Radiological Health Data

VOLUME III, NUMBER 6

JUNE 1962

MONTHLY REPORT

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and foreign governments. Except where material is directly quoted or otherwise credited, summaries and abstracts are prepared by the Radiological Health Data and Reports Staff, Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

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RADIOLOGICAL HEALTH DATA

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

ADVANCE REPORT

The AEC and Weather Bureau-predicted spring rise in fallout levels of strontium–89, strontium–90, and cesium–137 appears evident from preliminary data reported by the Public Health Service milk monitoring program. Comparisons of April network averages with those of the first quarter 1962 show increases (significant at the 90 percent confidence level) as shown in the table below. These increases are attributable to the expected spring rise rather than recent United States testing in the atmosphere.

Radionuclide	Network averages ($\mu\mu$c liter)	
	First quarter 1962	April 1962
Strontium–89	30	63
Strontium–90	8.7	12.0
Cesium–137	11	25

The May network average monthly tabulations for 61 stations in the milk sampling network shows 20 $\mu\mu$c/liter of iodine–131 in milk. During March and April the average value for milk was less than 10 $\mu\mu$c/liter. Relatively high levels were detected in several States located generally in the mid-west. Average levels of more than 20 $\mu\mu$c/liter were noted at 10 sampling stations. Values greater than 100 $\mu\mu$c/liter were determined at three stations. The monthly average for the station with the highest reported concentrations was 220 $\mu\mu$c/liter.

Air levels of gross beta radioactivity as determined by the Radiation Surveillance Network and the National Air Sampling Network have remained essentially the same as those measured previous to the reported increases in pasteurized milk iodine–131 levels. Gamma spectrometry on early May air samples, with gross beta measurements about 10 $\mu\mu$c/m^3, has shown iodine–131 to be less than one $\mu\mu$c/m^3 of air.

Editor's Note: The above information is preliminary and subject to further confirmation. It summarizes recent data submitted to the Radiation Surveillance Center, Division of Radiological Health, Public Health Service.

UNITS AND EQUIVALENTS

For the convenience of the reader, a selected list of units and equivalents frequently used in *Radiological Health Data* (*RHD*) are presented below.

Symbol	Name of unit	Equivalents
cpm	count per minute.	
dpm	disintegration per minute.	
$\mu\mu$c	micromicrocurie	1 $\mu\mu$c = 2.22 dpm.
mc/km^2	millicurie per square kilometer	1 mc/km^2 = 1000 $\mu\mu$c/m^2 = 2.59 mc/mi^2.
mi^2	square mile.	
m^2	square meter.	
m^3	cubic meter	1 m^3 = 1000 liters.
gm	gram.	
kg	kilogram	1 kg = 1000 gm.
mm	millimeter	precipitation: mm = $\frac{\mu\mu c/m^2}{\mu\mu c/liter}$
mr/hr	milliroentgen per hour.	

SECTION I.—AIR

Radiation Surveillance Network

Division of Radiological Health, Public Health Service

The Public Health Service Radiation Surveillance Network (RSN) was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in levels of radioactivity in air and precipitation due to fallout from nuclear weapons tests. Prior to September 1961, the Network consisted of 45 stations. Following the September 1961 resumption of nuclear weapons testing by the U.S.S.R., the Network was expanded over a period of a few months to 66 stations (see figure 1).

Air

Measurements of gross beta activity of particulates in surface air are taken because they provide one of the earliest and most sensitive indications of increases of activity in the environment and thus act as an "alert" system. A direct evaluation of biological effects is not possible from these data alone.

Daily 24-hour air samples are collected by a high volume air sampler with a carbon-loaded cellulose dust filter. Field measurements with a portable survey meter enable the station operator to estimate the amount of beta activity of particulates in air at the station five hours after collection by comparison with a known radioactive source. Each operator then reports his field estimates by telephone to the DRH Radiation Surveillance Center in Washington, D.C., to provide a daily national "alert" report. The filters are then forwarded to the central laboratory of the Radiation Surveillance Network for a more refined measurement using a thin-window gas flow proportional counter. The average fission product beta concentrations in surface air during March 1962 appear in table 1. The data shown represent the activities extrapolated to the time of collection.

Precipitation

Continuous sampling for total precipitation is conducted at each station on a daily basis using locally-made funnels having collection areas of 0.4 square meter (m^2). One-half liter of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory to be counted by the same method used for analyzing the air samples. The monthly averages of gross beta activity in precipitation, expressed in micromicrocuries per liter ($\mu\mu c$/liter) and micromicrocuries per square meter ($\mu\mu c/m^2$), are presented in table 2 for March 1962.

When the gross beta concentration of a given daily precipitation sample is too low for reliable measurement, an activity ($\mu\mu c/m^2$) calculated from the minimum level of detection is included in the monthly summation of activity. In the event that the sum of such "less-than"

TABLE 1.—GROSS BETA ACTIVITY OF PARTICULATES IN AIR, RSN, MARCH 1962

Station location		Number samples	Maximum	Minimum	Average[1]	Station location		Number samples	Maximum	Minimum	Average[1]
City	State					City	State				
Adak	Alaska	22	5.9	0.50	2.4	Minneapolis	Minn	24	9.8	1.9	4.8
Anchorage	Alaska	24	8.0	0.78	5.7	Jackson	Miss	24	9.8	2.0	6.0
Attu	Alaska	24	9.1	0.79	3.4	Pascagoula	Miss	22	15	2.0	8.0
Cold Bay	Alaska	24	8.9	0.38	3.0	Jefferson City	Mo	24	9.1	2.0	5.1
Fairbanks	Alaska	23	6.1	1.0	4.2						
						Helena	Mont	24	11	2.3	5.5
Juneau	Alaska	20	8.2	<0.10	3.6	Lincoln	Nebr	13	8.4	2.7	5.0
Kodiak	Alaska	24	7.9	0.27	4.7	Trenton	N. J	22	6.6	0.66	3.9
Nome	Alaska	1	2.6	2.6	2.6	Santa Fe	N. Mex	23	21	4.7	9.9
Point Barrow	Alaska	7	2.2	1.0	1.5	Albany	N. Y	24	9.5	0.25	5.2
St. Paul Island	Alaska	19	3.9	0.76	2.5						
						Buffalo	N. Y	3	10	4.1	8.0
Phoenix	Ariz	24	15	4.1	9.2	New York	N. Y	9	11	2.7	7.3
Little Rock	Ark	24	9.3	2.4	5.8	Gastonia	N. C	24	13	0.76	7.3
Berkeley	Calif	24	22	0.86	5.0	Bismarck	N. D	23	8.2	1.6	4.1
Los Angeles	Calif	23	16	2.5	7.4	Columbus	Ohio	21	12	2.3	7.4
Denver	Colo	22	16	3.4	7.2						
						Oklahoma City	Okla	24	12	4.4	8.2
Hartford	Conn	24	7.8	0.63	4.0	Ponca City	Okla	24	5.7	1.9	3.2
Washington	D. C	30	9.8	1.1	4.8	Portland	Oreg	22	12	0.71	5.3
Jacksonville	Fla	24	16	2.5	9.3	Harrisburg	Pa	23	25	1.2	6.1
Miami	Fla	24	11	2.3	6.9	San Juan	P. R	9	12	1.9	7.1
Atlanta	Ga	24	12	1.3	5.3						
						Providence	R. I	24	8.2	0.45	4.5
Agana	Guam	18	7.2	1.4	3.4	Columbia	S. C	24	8.6	0.81	5.2
Honolulu	Hawaii	23	5.6	0.61	3.3	Pierre	S. D	30	7.1	1.4	4.2
Boise	Idaho	23	14	2.6	6.9	Nashville	Tenn	23	13	2.2	6.7
Springfield	Ill	24	9.6	1.7	4.9	Austin	Tex	23	10	2.8	7.7
Indianapolis	Ind	24	12	1.5	5.6						
						El Paso	Tex	23	15	2.7	9.2
Iowa City	Iowa	23	9.3	0.71	4.8	Salt Lake City	Utah	24	13	2.6	6.6
Topeka	Kans	24	9.4	3.1	6.0	Richmond	Va	24	7.7	1.5	4.4
Frankfort	Ky	25	11	2.4	7.4	Seattle	Wash	24	6.5	0.69	2.7
New Orleans	La	24	11	1.6	6.6	Madison	Wis	24	10	3.2	6.1
Augusta	Maine	29	8.2	0.26	4.0						
						Cheyenne	Wyo	24	12	2.4	6.3
Presque Isle	Maine	10	5.7	0.44	2.7	Sundance	Wyo	11	11	3.0	5.6
Baltimore	Md	23	10	1.1	5.4						
Lawrence	Mass	23	5.7	0.91	3.7						
Winchester	Mass	3	6.4	1.0	3.0	Network average					5.47
Lansing	Mich	31	18	2.3	7.9						

[1] Weighted average obtained by summing the products of individual sampling times and the corresponding activities, and dividing by the summation of the individual sampling times.

TABLE 2.—GROSS BETA ACTIVITY IN PRECIPITATION, RSN, MARCH 1962

Station location		Average concentration (μμc/liter)	Total activity (μμc/m²)	Station location		Average concentration (μμc/liter)	Total activity (μμc/m²)
City	State			City	State		
Adak	Alaska	[a]—	—	Lansing	Mich	1,700	31,000
Anchorage	Alaska	880	3,400	Minneapolis	Minn	980	29,000
Attu	Alaska	—	—	Jackson	Miss	2,200	42,000
Cold Bay	Alaska	—	—	Pascagoula	Miss	—	—
Fairbanks	Alaska	1,100	12,000	Jefferson City	Mo	1,700	150,000
Juneau	Alaska	900	280,000	Helena	Mont	3,300	28,000
Kodiak	Alaska	—	—	Lincoln	Nebr	4,400	140,000
Nome	Alaska	—	—	Trenton	N. J	360	5,000
Point Barrow	Alaska	—	—	Santa Fe	N. Mex	3,200	55,000
St. Paul Island	Alaska	—	—	Albany	N. Y	1,000	21,000
Phoenix	Ariz	—	—	Buffalo	N. Y	—	—
Little Rock	Ark	2,600	330,000	New York	N. Y	—	—
Berkeley	Calif	1,100	95,000	Gastonia	N. C	1,300	150,000
Los Angeles	Calif	2,000	56,000	Bismarck	N. D	1,800	11,000
Denver	Colo	1,200	1,300	Columbus	Ohio	2,100	89,000
Hartford	Conn	1,300	42,000	Oklahoma City	Okla	—	—
Washington	D. C	1,000	91,000	Ponca City	Okla	1,400	32,000
Jacksonville	Fla	1,100	99,000	Portland	Oreg	930	36,000
Atlanta	Ga	1,700	180,000	Harrisburg	Pa	1,800	9,000
Agana	Guam	—	—	San Juan	P. R	—	—
Honolulu	Hawaii	1,100	69,000	Providence	R. I	1,600	55,000
Boise	Idaho	860	24,000	Columbia	S. C	1,900	210,000
Springfield	Ill	—	—	Pierre	S. D	370	3,200
Indianapolis	Ind	2,200	190,000	Nashville	Tenn	1,900	83,000
Iowa City	Iowa	3,200	190,000	Austin	Tex	2,300	70,000
Topeka	Kans	2,600	75,000	El Paso	Tex	2,200	5,000
Frankfort	Ky	1,700	90,000	Salt Lake City	Utah	2,900	180,000
New Orleans	La	2,500	78,000	Richmond	Va	1,100	100,000
Augusta	Maine	2,300	100,000	Seattle	Wash	4,400	230,000
Presque Isle	Maine	—	—	Madison	Wis	1,900	69,000
Baltimore	Md	—	—				
Lawrence	Mass	1,700	50,000	Cheyenne	Wyo	2,900	12,000
Winchester	Mass	—	—	Sundance	Wyo	—	—

[a] Dash denotes no evaporated sample received.

activities is greater than one-tenth of the total gross beta activity for the month, the monthly activity is reported with a less-than (<) sign.

Review: Geographical Distribution of Fission Product Beta Concentrations in Air, September 1961 through February 1962

Beginning with this issue, monthly average fission product concentrations in air (based on laboratory measurements) will be indicated on the sampling station map (figure 1) by means of iso-concentration lines. For comparison, similar maps for the months August 1961 through February 1962 are presented in figure 2. [*Editor's Note: External gamma data submitted by RSN is reported in section 5.*]

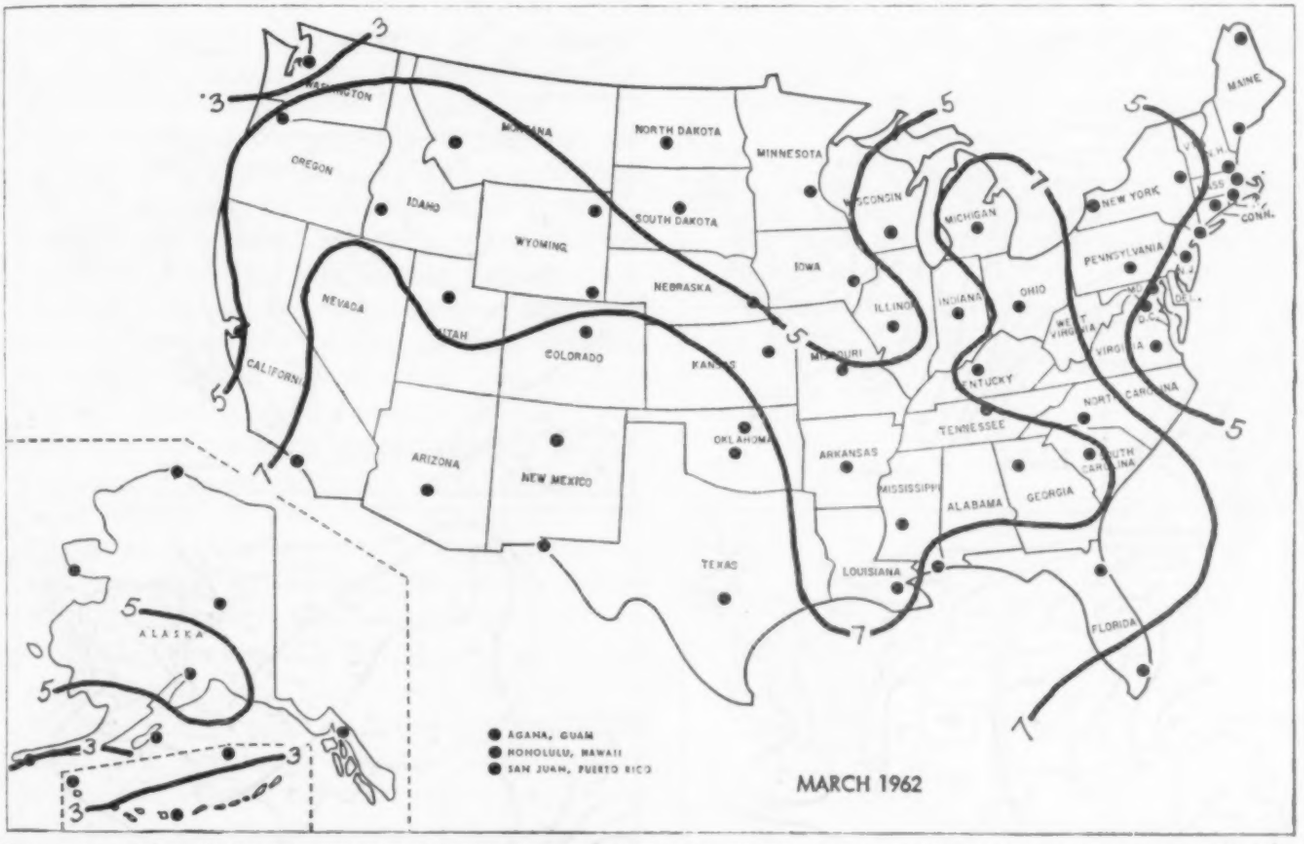

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS AND AVERAGE FISSION PRODUCT BETA CONCENTRATIONS IN AIR ($\mu\mu c/m^3$), MARCH 1962

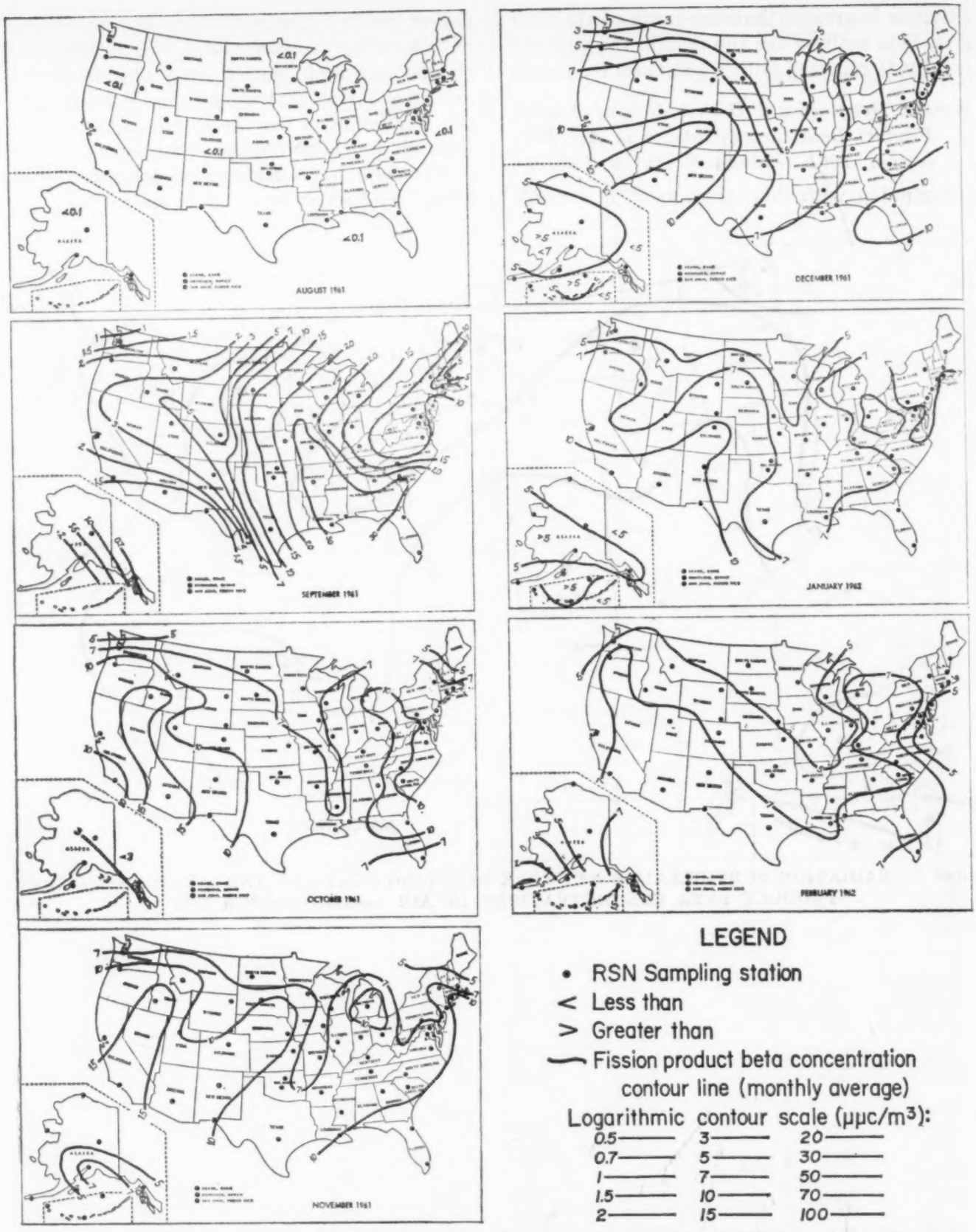

FIGURE 2.—REVIEW OF RADIATION SURVEILLANCE NETWORK MONTHLY AVERAGE FISSION PRODUCT BETA CONCENTRATIONS IN AIR, AUGUST 1961–FEBRUARY 1962

Surface Air Radon, Thoron, and Fission Product Gross Beta Concentrations at Cincinnati, Ohio

Division of Radiological Health, Public Health Service

The determination of natural background radiation in our atmosphere is useful because the exposure levels from natural radiation can be used as a base for comparative evaluations of exposures from artificially produced radionuclides. Natural radioactivity in surface air is attributed to a number of unstable nuclides other than those produced by man. The earth's crust contains trace amounts of uranium and thorium that occur naturally and which decay through a series of their daughter products. These decay products of uranium and thorium are introduced into surface air through their rare gas daughters, radon (radon–222) and thoron (radon–220), which in turn continue to decay through the uranium and thorium series, respectively. The radon and thoron content of air depends on the escape of these rare radioactive gases from the earth. Concentrations depend on prevailing atmospheric conditions such as ambient temperature, humidity, and pressure, and on soil conditions such as moisture, porosity, and temperature.

Most of the natural radioactivity in surface air is due to radon (Rn^{222}) and its daughters. Thoron (Rn^{220}) and its daughters contribute much less because of thoron's short half-life and hence, a lower diffusion rate from the soil.

Radiological Health Research Activities, Research Branch, Division of Radiological Health, Public Health Service, performs a continuous daily sampling program at Cincinnati for radon, thoron, and gross beta fission product concentrations in surface air. The airborne particulates, which include the daughter products of radon and thoron, are collected continuously on a membrane filter surface at a rate of approximately 1.2 cubic meters of air per hour.

Radon–222 concentrations are determined from alpha measurements made immediately after the sampling period (24 to 72 hours) has ceased. Radon–222 (a.m.) concentrations have been corrected for any radon–220 daughter interferences. Radon–222 (p.m.) concentrations are derived from alpha measurements made in the afternoon (3 p.m.) approximately 7 hours after the new sampling period has begun. These values are from the same filters that are counted at 8 a.m. the following day. Radon–222 (p.m.) concentrations are uncorrected for any radon–220 daughter interferences. Radon–220 concentrations are determined from alpha measurements made on the sample used to evaluate the corrected radon–222 (a.m.) concentrations, but are counted 7 hours after the sampling period has ceased. Reported values are corrected to the time of removal of the filter. The gross beta activity of airborne particulates, when measured several days after sample collection, is due principally to artificially-produced fission products.

The data are computed by an electronic data processing system which is programmed for

TABLE 1.—SURFACE AIR RADON (Rn^{222}), THORON (Rn^{220}), AND FISSION PRODUCT BETA CONCENTRATIONS AT CINCINNATI, OHIO, FEBRUARY 26–MARCH 23, 1962

End of sampling period	Rn^{222} 8 a.m. ($\mu\mu c/m^3$)	Rn^{222} 3 p.m. ($\mu\mu c/m^3$)	Rn^{220} ($\mu\mu c/m^3$)	Beta activity ($\mu\mu c/m^3$)
February 26	100	90	1.1	7.96
27	100	70	0.5	4.41
28	60	50	0.4	2.17
March 1	120	30	0.4	7.44
2	80	90	0.5	8.12
5	110	40	1.7	12.19
6	50	40	0.4	7.42
7	40	30	0.4	3.89
8	150	60	1.0	8.53
9	130	110	1.1	8.59
12	110	110	1.2	3.59
13	120	80	0.5	7.07
14	80	100	0.4	5.10
15	100	80	0.7	8.48
16	320	70	2.6	7.80
19	220	120	3.2	3.62
20	130	90	1.4	23.01
21	140	130	0.9	9.19
22	90	80	0.5	12.05
23	100	90	0.6	5.87
Average	122	81	1.2	7.54
Range of counting errors (2σ):				
Maximum	31	20	0.6	0.28
Minimum	11	9	0.2	0.06

thirteen four-week periods per calendar year. The data for the period February 26–March 23, 1962 appear in table 1.

REFERENCE

Setter, L. R. and G. I. Coats "The Determination of Airborne Radioactivity," *American Industrial Hygiene Association Journal, 22,* No. 1, Feb. 1961.

Radioactivity Measurements in Surface Air Near the 80th Meridian West

U.S. Naval Research Laboratory

Radioactivity measurements of surface air samples collected at various sites near the 80th Meridian West have been made since 1956. This program is operated by the U.S. Naval Research Laboratory with the cooperation of interested agencies of the United States, Canada, Ecuador, Peru, Bolivia, and Chile, which have made the actual sample collections and forwarded them to NRL for analysis. Partial financial support of this program is provided by the Division of Biology and Medicine, U.S. Atomic Energy Commission.

The sampling procedure involves drawing air continuously for a seven-day period at a rate of approximately 1200 cubic meters per day through high efficiency filters, 8 inches in diameter, using positive displacement blowers. After a sample is removed, it is forwarded immediately to NRL for assay of gross beta activity two weeks after collection.

The fission product concentrations in air during February 1962 are presented in table 1, and the radioactivity profile along the 80th Meridian West for the same month is shown in figure 1. This figure illustrates the data

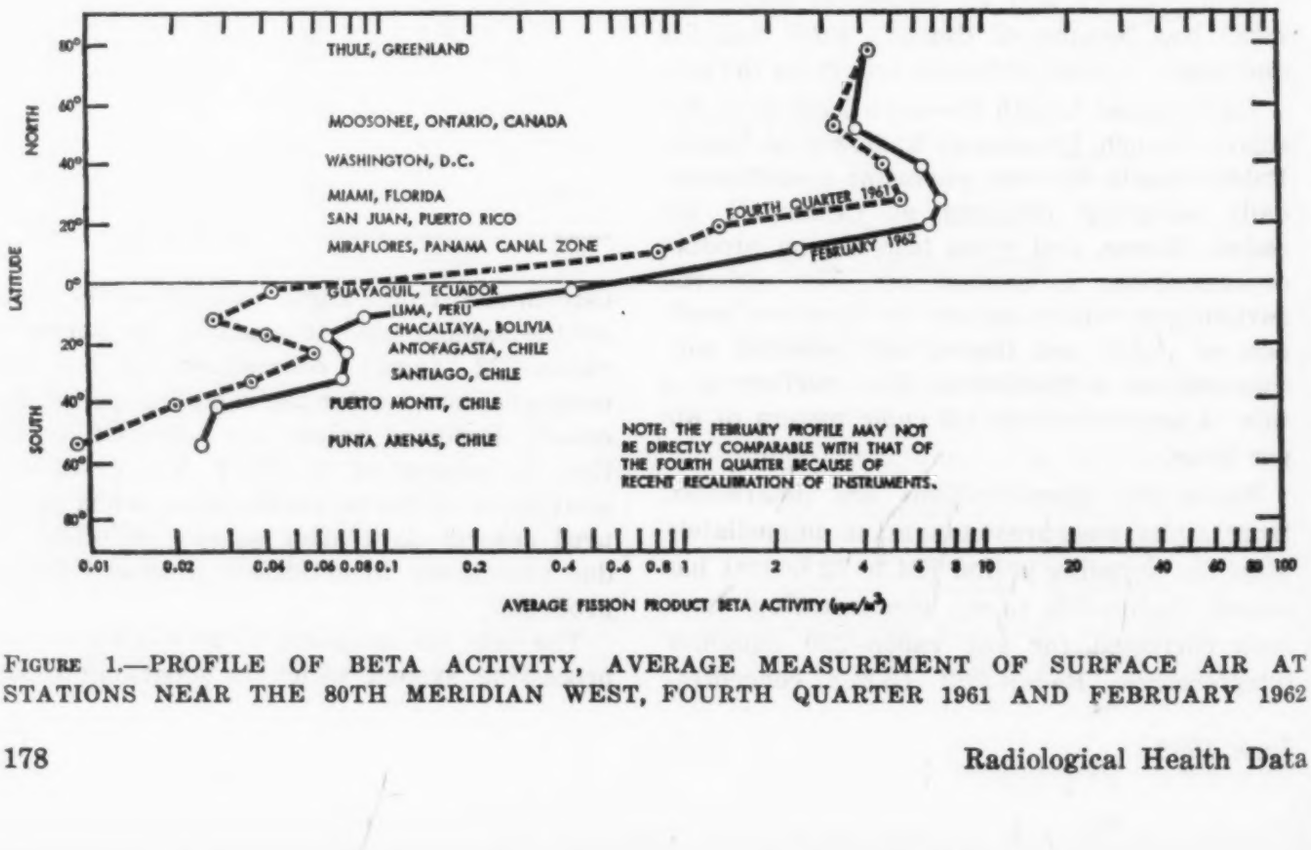

FIGURE 1.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENT OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN WEST, FOURTH QUARTER 1961 AND FEBRUARY 1962

TABLE 1.—FISSION PRODUCT BETA ACTIVITY IN SURFACE AIR, NRL, FEBRUARY 1962[a]

[Average concentrations in μμc/liter]

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Can. Z.	San Juan, P. R.	Mauna Loa, Hawaii[b]	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule, Greenland
1														
2														
3	0.024	0.011	0.103	0.079	0.026	0.038	0.829	2.59	3.88	1.30	8.01	5.54	2.74	
4														4.49
5														
6														
7														
8														
9	[c]—	0.041	0.071	0.073	0.040	0.078	0.166	1.81	3.88	3.54	7.24	7.92	3.40	
10														3.84
11														
12														
13														
14														
15														
16	0.032	0.021	0.064	0.071	0.172	0.101	0.429	3.42	11.52	4.35	9.63	6.03	3.69	
17														4.64
18														
19														
20														
21														
22														
23	0.018	0.025	0.054	0.065	0.026	0.117	0.333	2.16	7.29	9.54	5.44	6.26	5.13	
24														3.54
25														
26														
27	0.028	0.026	0.028	0.137	0.030	0.108	0.698	2.68	7.29	6.08	4.34	5.85	5.54	
28														8.37
Weighted average	0.025	0.028	0.069	0.076	0.066	0.089	0.430	2.50	6.88	5.04	7.34	6.48	3.94	4.23

[a] The average concentration determined from a given sample is placed at the center of a rectangle which indicates the length and dates of the sampling period. Station averages for the month were determined by weighting the sample averages according to the number of days in the sampling period or that portion of the sampling period occurring in February 1962.

[b] Mauna Loa data has been included for comparison with Chacaltaya, Bolivia. Both are high elevation stations (3400 and 5200 meters) and about equally distant north and south of the equator.

[c] Dash indicates sample was not received.

plotted in semilogarithmic coordinates. The abscissa is expressed in micromicrocuries per cubic meter of surface air.

The gross beta measurements indicate the increasing penetration into the Southern Hemisphere of radioactivity from the 1961 Soviet nuclear test series. The evidence is clear from comparisons with the radioactivity records for 1960 and 1961 that this activity is appearing in some quantity as far south as Lima and Chacaltaya; for example, the gross beta radioactivity in February 1962 at these sites is about 5-fold higher than in February 1961, while at Guayaquil it is nearly 20 times greater this year.

It is reasonable to postulate that the mechanism by which this activity reaches the southern hemisphere is through the transequatorial exchange of tropospheric air masses from the two hemispheres.

SECTION II.—FOOD

Radioactivity of Leafy Vegetables and Grasses Exposed to Fallout Originating From U.S.S.R. Nuclear Atmospheric Tests

Food and Drug Administration

The Food and Drug Administration collected four groups of leafy vegetables and grasses during the months of September, October, and November 1961, when high concentrations of fission product beta activity in air were reported by the Public Health Service Radiation Surveillance Network. An attempt was made to ascertain these vegetation samples from the same general areas sampled by the Radiation Surveillance Network for gross beta concentrations in air. The results of analyses for "total beta" and "total gamma," corrected for the presence of naturally-occurring potassium–40, are presented in table 1. The values given for the leafy vegetables and grasses represent the concentrations on an original unwashed weight basis at the time of analysis.

Comparison of Beta Activity in Air and Vegetation

Plotted on the upper portion of figure 1 are the average gross beta (fission product) concentrations in air associated with each sampling group in this study. The numbers in parentheses indicate the number of air sampling locations represented by the average. Daily air samples were taken at each of these locations during the 14-day period ending approximately on the date of leafy vegetation collection. Plotted on the lower portion of figure 1 are the average concentrations of total beta in leafy vegetables and grasses collected at the end of the air sampling periods. Prior to September 15, the air levels obtained by the Radiation Surveillance Network remained at a fairly constant value of less than 0.1 $\mu\mu c/m^3$ as indicated in figure 1. Data on activity in leafy vegetation for this corresponding period is lacking in these areas, but it can be assumed that the absence of nuclear testing prior to September 1 would be reflected by relatively low levels on vegetation, as suggested by the dotted section of the graph shown in the lower portion of figure 1.

It may be assumed that the total beta concentrations in vegetation represent the integration of fallout (both in air and precipitation) over relatively long periods of time—six weeks or longer. The relative constancy of these concentrations after the initial increase (see figure 1) probably represents a balance between the decay of short-lived, and the accumulation of intermediate or long-lived radionuclides.

Figure 1 appears to demonstrate that sampling for gross beta concentrations in air can provide an early alerting mechanism for vegetation sampling even though their usefulness for predicting radioactivity concentrations in

TABLE 1.—RADIOACTIVITY OF RAW AGRICULTURAL PRODUCTS EXPOSED TO FALLOUT ORIGINATING FROM SOVIET NUCLEAR ATMOSPHERIC TESTS, FALL 1961

Group	Product	Sampling location	Activity of raw product		Gross beta in PHS air samples[3] ($\mu\mu c/m^3$)
			Beta[1] ($\mu\mu c/gm$)	Gamma[2] (cpm/gm)	
Group I Collected: September 23-25 Analyzed: September 26-29	Grass	Jacksonville, Fla.	84	624	43
	Grass	Jacksonville, Fla.	111		
	Grass	Jacksonville, Fla.	6.8		Jacksonville, Fla.
	Grass	Jacksonville, Fla.	108		
	Grass	Jacksonville, Fla.	75		
	Grass	Orangeburg Co., S. C.	29		
	Grass	Orangeburg Co., S. C.	22		
	Collard greens	Orangeburg Co., S. C.	12		65
	Grass (Bermuda)	Orangeburg Co., S. C.	11	120	
	Grass	Orangeburg Co., S. C.	13		Columbia, S. C.
	Grass	Pulaski Co., Ark.	32		
	Cabbage	Pulaski Co., Ark.	0.45	1.92	92
	Turnip greens	Pulaski Co., Ark.	10	64	
	Turnip greens	Pulaski Co., Ark.	10	64	Little Rock, Ark.
	Rape greens	Pulaski Co., Ark.	4.3		
	Turnip greens	Lawrence Co., Mo.	11	376	
	Celery cabbage	Green Co., Mo.	3.8		79
	Lawn grass	Green Co., Mo.	36		
	Turnip greens	Webster Co., Mo.	8.8		Jefferson City, Mo
	Celery cabbage	Webster Co., Mo.	2.7		
	Cauliflower	Jackson Co., Miss.	5.4		
	Soybean vines	Jackson Co., Miss.	12		
	Grass	Jackson Co., Miss.	19		89
	Turnip greens	Jackson Co., Miss.	7.7		
	Collard greens	Jackson Co., Miss.	5.0		Pascagoula, Miss.
	Kudzu vine	Jackson Co., Miss.	21	104	
	Grass	New Orleans, La.	31		
	Collard greens	New Orleans, La.	3.2		75
	Mustard greens	New Orleans, La.	8.6		
	Okra	La Place, La.	0.63	0.96	New Orleans, La.
	Collard greens	Montgomery, Ala.	5.0	9.6	
	Sorghum cane	Montgomery, Ala.	1.8	104	
	Mustard greens	Montgomery, Ala.	23		[4] 92
	Grass	Montgomery, Ala.	26		
	Turnip greens	Montgomery, Ala.	1.4		Montgomery, Ala.
	Grass	Atlanta, Ga.	48	192	
	Lespedeza hay	Atlanta, Ga.	40		45
	Collard greens	Atlanta, Ga.	6.3		
	Soybean vines	Atlanta, Ga.	16		Atlanta, Ga.
	Crowder pea vines	Atlanta, Ga.	11		
Group II Collected: October 2 & 5 Analyzed: October 5 & 12	Turnip greens	Springfield, Ill.	5.0	24	
	Grass	Springfield, Ill.	16	29	32
	Turnip greens	Springfield, Ill.	6.8		
	Turnip greens	Springfield, Ill.	4.1		Springfield, Ill.
	Mustard greens	Springfield, Ill.	5.0		
	Grass	Iowa City, Iowa	193	95	
	Cabbage	Iowa City, Iowa	3.2		38
	Rape greens	Iowa City, Iowa	5.4		
	Alfalfa	Iowa City, Iowa	25		Iowa City, Iowa
	Turnip greens	Iowa City, Iowa	16	25	
	Leaf lettuce	Minneapolis, Minn.	41		
	Romaine lettuce	Minneapolis, Minn.	64	122	33
	Cabbage	Minneapolis, Minn.	0.45		
	Cabbage	Minneapolis, Minn.	0.45	3.7	Minneapolis, Minn.
	Grass	Minneapolis, Minn.	22	336	
	Cabbage	Madison, Wis.	0.45		
	Leaf lettuce	Madison, Wis.	2.7		30
	Grass	Madison, Wis.	204		
	Alfalfa	Madison, Wis.	19	18	Madison, Wis.
	Cabbage	Madison, Wis.	0.18		
	Collards	Jacksonville, Fla.	3.2		
	Collards	Jacksonville, Fla.	3.2		13
	Collards	Jacksonville, Fla.	1.6		
	Collards	Jacksonville, Fla.	2.2		Jacksonville, Fla.
	Greens	Jacksonville, Fla.	2.0		
Group III (Precipitation) Collected: November 1 & 2 Analyzed: November 3 & 6	Turnip greens	Nashville, Tenn.	31	21	7
	Mustard greens	Nashville, Tenn.	5.9		
	Greens	Ridgetop, Tenn.	15		
	Beet greens	Davidson Co., Tenn.	32	10	Nashville, Tenn.
	Chinese cabbage	Nashville, Tenn.	0.63	2.6	
	Mustard greens	Cave City, Ky.	9.5	13	
	Turnip greens	Cave City, Ky.	23		10
	Savoy cabbage	Hart Co., Ky.	6.3		
	Kale	Hart Co., Ky.	6.8		Frankfort, Ky.
	Cabbage	Kessinger, Ky.	3.2		

TABLE 1.—RADIOACTIVITY OF RAW AGRICULTURAL PRODUCTS EXPOSED TO FALLOUT FROM SOVIET NUCLEAR ATMOSPHERIC TESTS, FALL 1961—Continued

Group	Product	Sampling location	Activity of raw product		Gross beta in PHS air ampmles[4] ($\mu\mu c^2/m^4$)
			Beta[1] ($\mu\mu c$/gm)	Gamma[2] (cpm/gm)	
Group IV (Precipitation)					
Collected: November 17 & 18	Turnip greens	Wicomico Co., Md.	20		12
	Collards	Baltimore Co., Md.	6.3	167	
Analyzed: November 21-23	Spinach	Baltimore Co., Md.	9.1		Baltimore, Md.
	Kale	Washington Co., Va.	3.7		13
	Turnip greens	Washington Co., Va.	7.2		
	Mustard greens	Botetourt Co., Va.	37		Washington, D. C.
	Cabbage	Pasquotank Co., N. C.	0.58	0.56	
	Cabbage	Norfolk Co., Va.	0.45		9
	Turnip greens	Somerset Co., Md.	13		
	Spinach	Dorchester Co., Md.	41	30	Gastonia, N. C.
	Lawn grass	Falls Church, Va.	—	190	

[1] Measured on 400 mg of ash in a low background beta counter. Values corrected for the presence of K^{40}. Efficiency: 20%.
[2] Measured on 3½ liters of finely chopped raw product packed in a Marinelli beaker with a 400-channel gamma spectrometer. Gamma activity (counts per minute) defined as number of photons detected in the energy range of 0–1.9 Mev. Values corrected for background, for the presence of K^{40} (1.4 Mev peak), and the counting efficiency (12%).
[3] Average of 14 daily air samples with collection ending approximately on date of raw agricultural product collection.
[4] Based on preliminary field measurements, not official station of Radiation Surveillance Network.

vegetation at a later time is limited. It is recognized that in addition to the air parameter, precipitation, wind speed and direction, particle size, and fission product age are other equally important factors not considered in this study. *For this reason, figure 1 should not be used for prediction of beta concentrations in vegetation.*

Comparison to 1958

Lettuce and spinach samples were obtained in the Los Angeles area during November 1958 when northeasterly winds occurred following atmospheric nuclear weapons testing at the Nevada Test Site. A comparison of the average total beta concentration in the spinach and lettuce samples with the average concentration in all samples in Group I (average of fallout,

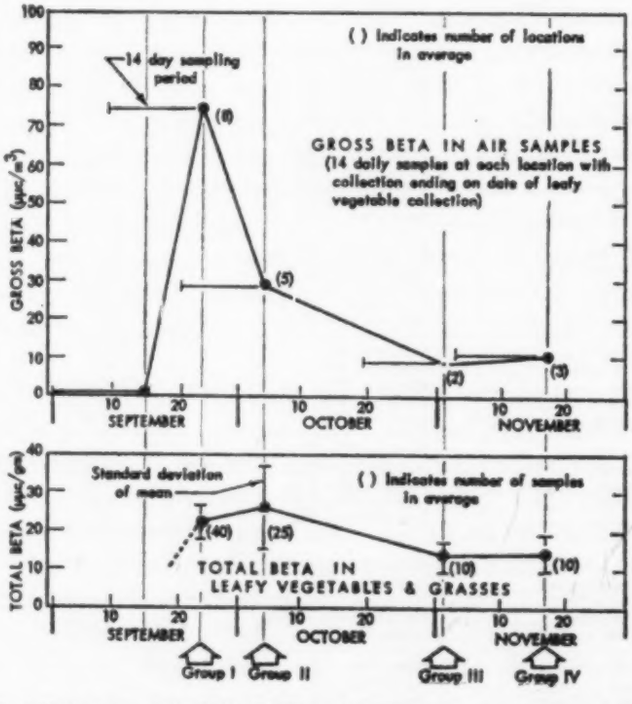
( ) Indicates number of locations in average
14 day sampling period
GROSS BETA IN AIR SAMPLES
(14 daily samples at each location with collection ending on date of leafy vegetable collection)
GROSS BETA (μμc/m³)
SEPTEMBER
OCTOBER
NOVEMBER
Standard deviation of mean
( ) Indicates number of samples in average
TOTAL BETA IN LEAFY VEGETABLES & GRASSES
TOTAL BETA (μμc/gm)
Group I
Group II
Group III
Group IV

FIGURE 1.—COMPARISON OF AVERAGE TOTAL BETA ACTIVITY IN LEAFY VEGETABLES AND GRASSES AND IN AIR

1–2 weeks) shows: lettuce and spinach (1958), 33 μμc/gm; Group I (1961), 22.1 μμc/gm.

Strontium–90

Food and Drug Administration laboratory data on the relationship of strontium–90 to total beta in food samples support the assumption that the strontium–90 content of food samples containing fallout of an age 1 to 4 weeks old is on the order of 0.1 percent of the total beta measured. From this assumption, it is estimated that no strontium–90 concentration in any human food sampled in Groups I through IV in table 1 could lead to a daily ingestion in excess of 200 μμc (top of Range II, "Federal Radiation Council Report No. 2"), even if the item of food constituted the entire daily intake.

Iodine–131

From the presumed iodine–131 peaks of the 0 to 1.9 Mev gamma spectrum recorded by a 400–channel gamma spectrometer, iodine–131 was estimated to be not more than 5 percent of the total gamma for Group I. Using this estimate, turnip greens showing the highest total gamma reading would not have contained more than 8,000 μμc I^{131}/kg. Since the top of Range II given by the Federal Radiation Council Report No. 2 for iodine–131 is 100 μμc/day, it would be possible to reach this level of intake if 12.5 grams of turnip greens of the highest iodine–131 concentration were ingested daily. *It must be remembered also that such daily intake rates would have to be maintained for a year.*

Tri-City Diet Study[1]

Joseph Rivera
Health and Safety Laboratory, U.S. Atomic Energy Commission

Approximately every three months, since May 1960, estimates of the strontium–90 content of average diets for individuals living in New York City, San Francisco, and Chicago have been made by the Health and Safety Laboratory.

Selected foods, representing 19 food categories, are purchased at each of these three cities about every three months and are analyzed for strontium–90 and stable calcium. Using data from the U.S. Department of Agriculture, "Household Food Survey of 1955," the annual consumption by an individual can be grouped into the same 19 food categories. The annual dietary intake of strontium–90 and calcium can then be estimated by summing the contributions from each category. Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general. Hence, in the tables that follow, the values shown for food consumption may not be directly related to the original data in the source document.

The consumption data from the "Household Food Survey of 1955" are based on a "weight as purchased" basis. Before the food samples for the Tri-City Diet Study are ashed for radiochemical analysis, they are prepared to a certain degree, as if for actual consumption. Thus, fruits are peeled, eggs are shelled, poultry is de-boned, etc. The concentration of radioactivity in foods as reported in the Tri-City Diet Study is, therefore, based on the trimmed weight. No correction is made for the wasted food. Contributions of strontium–90 from tap water are not included in table 1, but measurements during 1960 and 1961 indicate the contribution would be in the range of 100 to 200 μμc Sr^{90} per year. It is assumed in making this estimate that the average daily intake of tap water is 1.2 liters.

Results obtained from the sixth sampling of foods (August–October 1961) are presented in table 1. The variation with time of the daily

[1] Data from *Quarterly Summary Report, HASL–122*, April 1, 1962.

TABLE 1.—STRONTIUM-90 LEVELS OF DIET—SIXTH SAMPLING

Food type	Annual consumption	New York City August 1961		Chicago October 1961		San Francisco September 1961	
	(kg/yr)	μμc/kg	μμc/yr	μμc/kg	μμc/yr	μμc/kg	μμc/yr
Whole grain products	11	11.4	126	9.6	106	6.1	67
Refined grain products	37	5.8	215	5.9	218	2.0	73
Refined grain flour	43	6.2	267	5.5	236	1.8	76
Milk, liquid	221	7.8	1728	3.2	716	1.6	343
Potatoes	45	—	[a] 206	2.8	125	1.1	50
Macaroni	3	2.2	7	4.5	14	1.2	4
Beans, dried	3	2.6	8	11.1	33	6.8	20
Vegetables, canned	20	2.6	52	4.6	92	0.5	11
Vegetables, fresh	43	9.9	424	7.8	335	1.3	56
Vegetables, root	17	2.1	36	4.8	81	5.0	85
Fruit, canned	26	1.3	34	0.8	22	0.5	12
Fruit juices	19	2.8	54	2.2	43	1.3	24
Fruit, fresh	68	1.2	81	2.2	147	0.8	55
Rice	3	1.1	3	1.2	4	1.0	3
Eggs	16	0.7	11	1.9	31	1.6	26
Fish, fresh	8	0.6	5	0.4	4	0.2	1
Fish, shell	1	1.1	1	0.6	1	0.2	2
Meat	73	0.4	31	0.4	29	0.6	41
Poultry	17	0.7	11	1.6	27	0.8	14
Total annual intake			3300		2264		961

[a] Estimated.

intake of strontium–90 at the three cities is plotted in figure 1.

From the data in table 1, we see that the previously noted differences in the intake of strontium–90 at the three cities persist. New York City diets were highest in strontium–90 intake, Chicago diets were slightly lower than those in New York City, and San Francisco diets were considerably lower than those in New York City or Chicago. While these differences were principally due to differences in the strontium–90 content of milk consumed in the cities, some persistent differences in the strontium–90 content of flour are also noted. This is somewhat surprising since it was thought that the flour consumed at the three cities would come from the same general source, and that, therefore, the strontium–90 found in flour purchased at any of the cities would be about the same. The lower strontium–90 concentrations found in flour purchased in San Francisco suggest that it was milled from wheat locally grown, since wheat grown on the west coast is known to have a lower strontium–90 content than the national average.

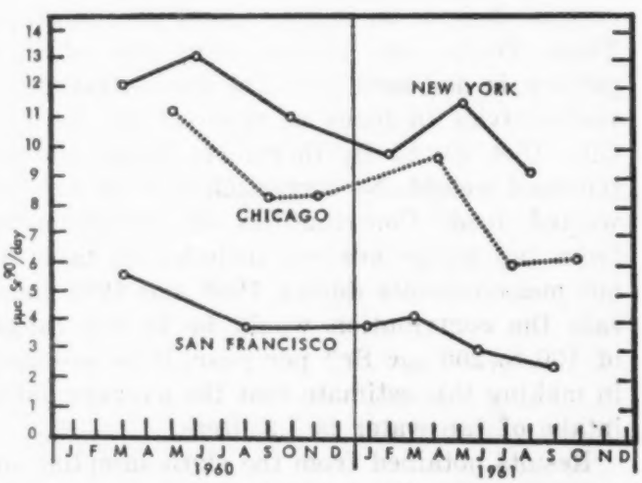

FIGURE 1.—DAILY INTAKE OF STRONTIUM–90 IN TRI-CITY DIETS

Two observations that may be made from figure 1 are that the daily strontium–90 intake at each of the cities during 1961 has generally declined and, superimposed on this general decline, there is evidence for a seasonal fluctuation with peak levels occurring during the spring months.

The seasonal dependence of strontium–90 intake levels are presumably due to a seasonal dependence of milk levels. We hope to be able to study these effects in more detail when we analyze foods that will be purchased in 1962, particularly in the spring when relatively heavy fallout is expected.

Using the totals given in table 1, the following average concentrations in μμc Sr^{90}/gm Ca may be expressed in units of annual intake: New York, 8.6; Chicago, 5.9; San Francisco, 2.5. This calculation was based on calcium data obtained from the first two sampling periods. Despite the fact that there is some variability in the results obtained from analyses of in-

dividual food categories, the total intake of calcium was calculated to be 383 grams per person per year with a standard deviation of less than 5 percent. Because of the relative constancy of the average annual intake of calcium due to its strong dependence on the relatively constant calcium content of milk, analyses of food categories, other than milk, for calcium were discontinued after the second sampling. Previous coverage in *Radiological Health Data*

Period	*Issue*
First Sampling (March–May 1960)	April 1961
Second Sampling (June-September 1960)	June 1961
Third Sampling (October 1960–January 1961)	October 1961
Fourth Sampling (February–April 1961)	December 1961
Fifth Sampling (May–July 1961)	March 1962

SECTION III.—MILK

Milk Monitoring Program

Division of Radiological Health
Division of Environmental Engineering and Food Protection
Public Health Service

Milk monitoring has been conducted by the Public Health Service since early 1957, when the first program was established to develop suitable sampling methods and radiochemical analytical proficiencies. Raw milk was initially selected for investigation. During this program, it became evident that a broader sampling program was necessary—one more directly related to the milk consumed by the population. The result was the initiation, in the first quarter of 1960, of a pasteurized milk sampling program designed to provide data representative of milk consumed in selected municipalities. Both programs were operated concurrently until June 1961 to permit comparison of the differences between the earlier, limited, milkshed sampling results and those of the new program.

Raw milk sampling results reported for June 1961 in the November 1961 *RHD* were the last regular publication of such data. A summary discussion of the raw milk sampling program in the December 1961 *RHD* presented the gross relationship between fallout and the occurrence of fission products in milk determined from this study.

During January 1962, the surveillance of pasteurized milk was conducted at 61 stations (shown in figure 1) with the cooperation of State and local milk sanitation agencies who ship samples to the PHS Southeastern and Southwestern Radiological Health Laboratories for analysis. The former analyzes samples from the 30 States generally east of the Mississippi River, and the latter analyzes samples from the western States. Publication in *RHD* follows about four months after sample collection because of time required for shipment, processing, decay-product buildup, data compilation, and publication procedures.

The current program emphasizes (1) measurement of the levels of radioactivity of samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within virtually all States and additional points when indicated by widely varying conditions of the milk supply or the need to cover large population groups. Each sample is composited in proportion to the volume of milk sold by those plants supplying not less than 90 percent of a city's milk supply. Prior to September 15, 1961, this composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions. Since

FIGURE 1.—PASTEURIZED MILK AREA SAMPLING STATIONS, JANUARY 1962

September 15, the sampling schedule has been accelerated.

During January 1962, sampling on a weekly basis was performed at most stations. Exceptions were Montgomery and Rapid City with one sample each and Burlington with two. All surveillance data is subject to continuing review and evaluation to observe unusual patterns or levels which may require immediate attention and adjustment in the pasteurized milk sampling program operation. Further atmospheric nuclear testing may require an immediate re-evaluation and readjustment of the sampling frequency and analytical schedule for this program.

Iodine–131, cesium–137, and barium–140 are

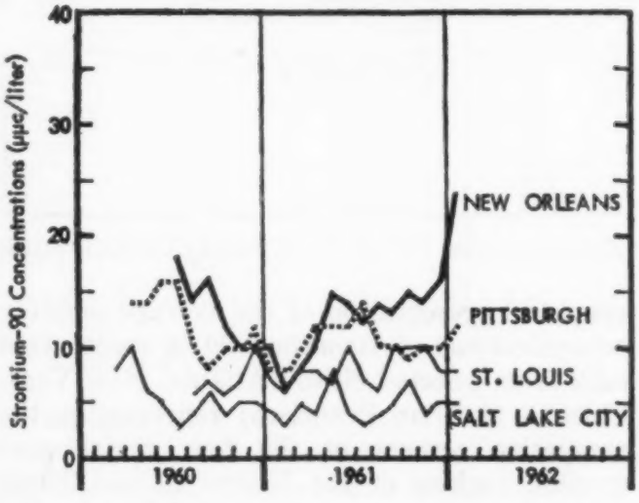

FIGURE 2.—STRONTIUM–90 CONCENTRATIONS IN PASTEURIZED MILK

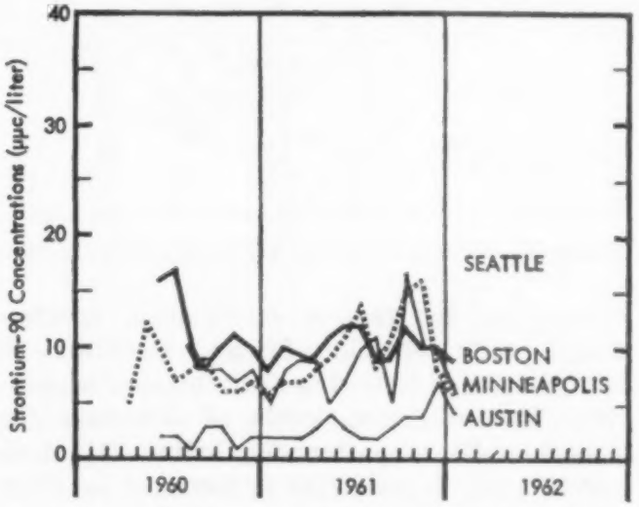

FIGURE 3.—STRONTIUM–90 CONCENTRATIONS IN PASTEURIZED MILK

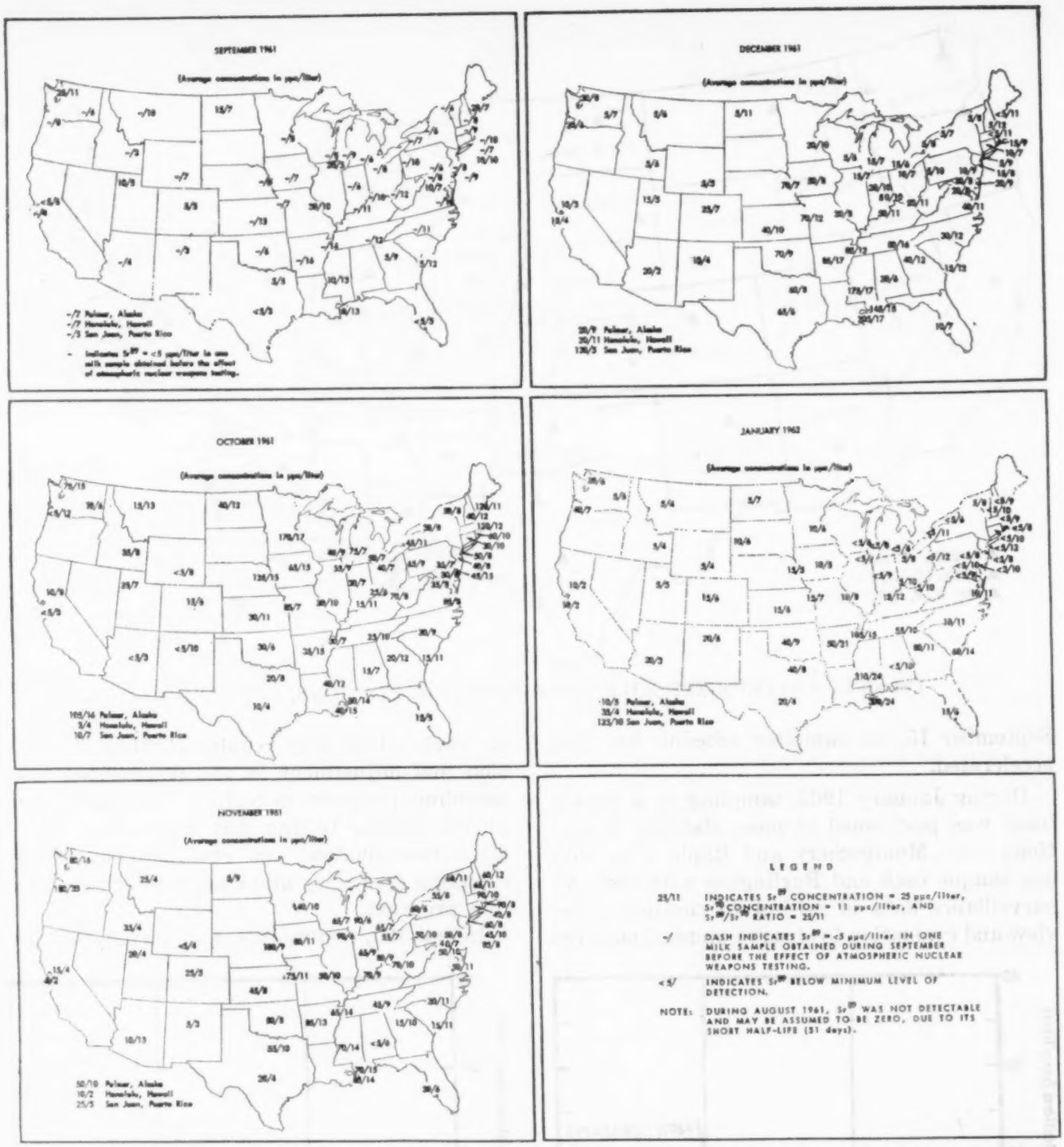
SEPTEMBER 1961
DECEMBER 1961
OCTOBER 1961
JANUARY 1962
NOVEMBER 1961
LEGEND
25/11 INDICATES Sr89 CONCENTRATION = 25 μμc/liter, Sr90 CONCENTRATION = 11 μμc/liter, AND Sr89/Sr90 RATIO = 25/11
-/- DASH INDICATES Sr89 = <5 μμc/liter IN ONE MILK SAMPLE OBTAINED DURING SEPTEMBER BEFORE THE EFFECT OF ATMOSPHERIC NUCLEAR WEAPONS TESTING.
<5/ INDICATES Sr89 BELOW MINIMUM LEVEL OF DETECTION.
NOTE: DURING AUGUST 1961, Sr89 WAS NOT DETECTABLE AND MAY BE ASSUMED TO BE ZERO, DUE TO ITS SHORT HALF-LIFE (51 days).

FIGURE 4.—STRONTIUM–89 AND STRONTIUM–90 CONCENTRATIONS (Sr^{89}/Sr^{90}) IN PASTEURIZED MILK

determined by gamma scintillation spectroscopy, while strontium–89 and strontium–90 are determined following radiochemical separation. The minimum levels of detection for strontium–89, strontium–90, iodine–131, cesium–137, and barium–140 in terms of μμc/liter are 5, 1, 10, 5, and 10, respectively.

The May 1962 *RHD* (page 151) published a graphical presentation of the average monthly concentrations of strontium–90 in pasteurized milk from selected cities (Atlanta, New York, Chicago, and San Francisco) representing the population centers of the four major geographic regions of the United States. These regions correspond to those used by the Department of Agriculture for their tabulations

TABLE 1.—RADIOACTIVITY IN PASTEURIZED MILK, JANUARY 1962

[Average radioactivity concentrations in $\mu\mu c$/liter]

Area		Calcium (gm/liter)		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
City	State	Fourth quarter	Av. for month	Fourth quarter	Av. for month	Fourth quarter	Av. for month	Fourth quarter	Av. for month	Fourth quarter	Av. for month	Fourth quarter	Av. for month
Montgomery	Ala	1.22	1.06	10	<5	6	10	20	<10	<5	20	20	20
Palmer	Alaska	1.10	1.04	60	10	12	5	130	<10	15	5	40	<10
Phoenix	Ariz	1.05	1.02	10	30	6	3	50	10	5	5	<10	<10
Little Rock	Ark	1.20	1.20	70	50	15	21	100	<10	20	10	30	20
Sacramento	Calif	1.13	1.02	10	10	5	2	20	<10	10	<5	<10	<10
San Francisco	Calif	1.09	1.03	10	10	3	2	20	20	5	5	<10	<10
Denver	Colo	1.10	1.01	20	15	6	6	50	10	10	10	10	<10
Hartford	Conn	1.17	1.16	25	<5	8	10	30	<10	10	<5	30	<10
Wilmington	Del	1.17	1.16	50	<5	11	10	40	<10	5	<5	30	<10
Washington	D. C	1.17	1.14	35	<5	9	9	30	<10	5	<5	20	<10
Tampa	Fla	1.22	1.22	20	15	6	6	30	<10	70	50	20	<10
Atlanta	Ga	1.20	1.17	25	80	11	11	50	<10	[a] 5	<5	20	20
Honolulu	Hawaii	1.07	1.04	10	35	6	4	20	<10	15	5	<10	<10
Idaho Falls	Idaho	1.05	1.04	25	5	6	4	80	<10	10	5	10	<10
Chicago	Ill	1.18	1.11	50	<5	7	6	80	<10	[a] 10	<5	40	<10
Indianapolis	Ind	1.21	1.20	40	<5	9	9	50	<10	<5	<5	20	<10
Des Moines	Iowa	1.06	1.03	65	10	11	5	180	10	10	10	20	<10
Wichita	Kans	1.06	1.02	40	15	10	6	100	10	10	<5	10	<10
Louisville	Ky	1.19	1.19	45	10	11	12	60	<10	<5	10	30	<10
New Orleans	La	1.26	1.24	105	300	15	24	60	<10	15	40	40	60
Portland	Maine	1.19	1.20	60	<5	11	9	50	<10	20	20	40	<10
Baltimore	Md	1.17	1.16	35	<5	8	10	40	<10	<5	10	20	<10
Boston	Mass	1.18	1.19	70	<5	11	9	60	<10	10	25	40	<10
Detroit	Mich	1.17	1.16	40	<5	7	6	100	<10	5	<5	30	<10
Grand Rapids	Mich	1.19	1.19	60	<5	7	8	50	<10	<5	<5	30	<10
Minneapolis	Minn	1.10	1.03	110	10	12	6	170	<10	15	5	40	<10
Jackson	Miss	1.28	1.28	95	210	14	24	70	<10	5	20	40	50
Pascagoula	Miss	1.27	[b] NS	80	NS	16	NS	60	NS	10	NS	30	NS
Kansas City	Mo	1.06	1.01	75	15	10	7	130	10	15	5	20	<10
St. Louis	Mo	1.08	1.02	35	10	9	8	90	<10	10	10	10	<10
Helena	Mont	1.07	1.06	15	5	8	4	100	<10	20	<5	10	<10
Omaha	Nebr	1.08	1.03	100	15	10	5	140	<10	10	<5	30	<10
Manchester	N. H	1.20	1.16	35	<5	12	10	50	<10	25	20	40	<10
Trenton	N. J	1.19	1.15	35	<5	9	8	40	<10	<5	<5	20	10
Albuquerque	N. Mex	1.09	1.03	5	20	6	6	30	10	10	5	<10	<10
Buffalo	N. Y	1.12	1.12	35	<5	8	11	40	<10	5	<5	20	<10
New York	N. Y	1.13	1.12	40	<5	8	12	50	<10	5	<5	30	<10
Syracuse	N. Y	1.16	1.15	50	<5	7	6	60	<10	10	<5	40	<10
Charlotte	N. C	1.27	1.21	25	10	11	11	20	<10	<5	<5	20	<10
Minot	N. D	1.09	1.02	15	5	11	7	60	<10	10	5	<10	<10
Cincinnati	Ohio	1.22	1.19	50	5	8	10	70	<10	<5	<5	30	<10
Cleveland	Ohio	1.18	1.17	35	5	7	8	50	<10	5	<5	20	<10
Oklahoma City	Okla	1.18	1.18	60	40	8	9	100	<10	10	<5	20	10
Portland	Oreg	1.05	1.02	70	40	17	7	80	<10	25	10	20	<10
Philadelphia	Pa	1.20	1.12	30	<5	8	8	40	<10	<5	<5	20	<10
Pittsburgh	Pa	1.16	1.18	40	<5	10	12	40	<10	5	<5	30	<10
San Juan	P. R	1.18	1.13	55	125	6	10	20	<10	10	10	20	30
Providence	R. I	1.18	1.16	55	<5	9	8	50	10	10	10	30	<10
Charleston	S. C	1.22	1.22	15	60	11	14	30	<10	20	20	20	10
Rapid City	S. D	NS	1.09	NS	10	NS	6	NS	<10	NS	15	NS	<10
Chattanooga	Tenn	1.27	1.25	50	55	12	10	50	<10	5	15	20	20
Memphis	Tenn	1.24	1.20	60	105	11	15	90	<10	10	<5	20	30
Austin	Tex	1.18	1.14	30	20	5	4	40	<10	[a] <5	<5	20	10
Dallas	Tex	1.23	1.24	45	40	9	8	50	<10	[a] <5	<5	20	10
Salt Lake City	Utah	1.11	1.07	20	5	5	5	60	10	10	10	10	10
Burlington	Vt	1.18	1.16	40	5	9	8	50	<10	10	20	30	<10
Norfolk	Va	1.23	1.20	60	10	10	11	40	<10	5	<5	20	<10
Seattle	Wash	1.11	1.02	60	20	13	6	80	10	20	15	20	<10
Spokane	Wash	[a] 1.12	1.02	[a] 10	5	[a] 6	6	60	<10	15	10	10	<10
Charleston	W. Va	1.18	1.16	55	5	10	10	30	<10	<5	<5	20	<10
Milwaukee	Wis	1.17	1.20	35	<5	7	6	80	<10	15	10	30	<10
Laramie	Wyo	1.09	1.03	<5	5	6	4	30	10	15	15	10	<10
Network average		1.16	1.12	43	25	9	8.5	61	<10	11	9	22	<10

[a] Average based on two months.
[b] NS indicates no sample.

of average "per person" quantities of foods consumed per week, as presented in the August, September, and October 1960 *RHD*. Figures 2 and 3 graphically show the data for eight additional cities selected from these regions. This procedure will be accelerated in future issues so that all cities in the program will be shown.

Figure 4 shows the strontium–89 and strontium–90 concentrations for September 1961 through January 1962 plotted on outline maps

TABLE 2.—ANNUAL SUMMARIES OF RADIOACTIVITY IN PASTEURIZED MILK, 1960–61
[Average radioactivity concentrations in μμc/liter]

Area		Calcium (gm/liter)		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
City	State	1960[a]	1961	1960[a]	1961	1960[a]	1961	1960[a]	1961	1960[a]	1961	1960[a]	1961
Montgomery[b]	Ala.	[c]—	1.22	—	<5	—	6	—	<10	—	<5	—	<10
Palmer	Alaska	1.07	1.08	<5	15	7	8	<10	30	<5	10	<10	10
Phoenix	Ariz.	1.02	1.04	<5	<5	4	4	<10	10	15	<5	<10	<10
Little Rock	Ark.	1.20	1.12	<5	20	13	16	<10	30	<5	15	<10	<10
Sacramento	Calif.	1.06	1.01	<5	<5	5	4	<10	<10	<5	5	<10	<10
San Francisco	Calif.	1.12	0.96	<5	<5	4	4	<10	<10	<5	5	<10	<10
Denver	Colo.	1.10	1.05	<5	5	7	6	<10	20	10	10	<10	<10
Hartford	Conn.	1.19	1.17	<5	5	9	8	<10	<10	10	15	<10	<10
Wilmington	Del.	1.21	1.19	<5	15	8	9	<10	10	10	10	<10	<10
Washington	D. C.	1.17	1.18	<5	10	8	8	<10	10	<5	10	<10	<10
Tampa	Fla.	1.26	1.24	<5	<5	5	6	<10	10	10	65	<10	<10
Atlanta	Ga.	1.24	1.12	<5	5	10	10	<10	20	<5	10	<10	<10
Honolulu	Hawaii	1.07	1.03	<5	<5	5	4	<10	<10	20	10	<10	<10
Idaho Falls	Idaho	1.07	1.04	<5	5	5	6	<10	20	20	5	<10	<10
Chicago	Ill.	1.15	1.06	<5	15	6	6	<10	30	<5	10	<10	10
Indianapolis	Ind.	1.20	1.22	<5	10	6	7	<10	10	<5	5	<10	<10
Des Moines	Iowa	1.04	1.05	<5	15	8	8	<10	50	15	5	<10	<10
Wichita	Kans.	1.08	1.05	<5	10	6	8	<10	30	<5	10	<10	<10
Louisville	Ky.	1.19	1.18	<5	10	9	10	<10	20	<5	5	<10	<10
New Orleans	La.	1.25	1.29	<5	30	13	12	<10	20	<5	15	<10	10
Portland	Maine	1.14	1.11	<5	15	11	9	<10	10	15	25	<10	10
Baltimore	Md.	1.16	1.21	<5	10	8	8	<10	10	<5	10	<10	<10
Boston	Mass.	1.19	1.21	<5	20	12	9	<10	20	15	20	<10	10
Detroit	Mich.	1.16	1.18	<5	10	7	6	<10	30	<5	5	<10	10
Grand Rapids	Mich.	1.25	1.21	<5	15	7	6	<10	10	5	5	<10	10
Minneapolis	Minn.	1.05	1.06	<5	30	8	9	<10	40	<5	10	<10	10
Jackson	Miss.	1.31	1.10	<5	15	12	12	<10	30	<5	10	<10	10
Pascagoula[b]	Miss.	—	1.27	—	20	—	16	—	30	—	10	—	<10
Kansas City	Mo.	1.06	1.05	<5	20	8	8	<10	30	10	10	<10	<10
St. Louis	Mo.	1.05	1.06	<5	10	7	8	<10	40	35	15	<10	<10
Helena	Mont.	1.08	1.04	<5	<5	6	6	<10	30	10	10	<10	<10
Omaha	Nebr.	1.04	1.08	<5	25	7	7	<10	40	5	15	<10	10
Manchester	N. H.	1.22	1.22	<5	10	10	10	<10	10	25	30	<10	10
Trenton	N. J.	1.22	1.18	<5	10	8	8	<10	10	5	5	<10	<10
Albuquerque	N. Mex.	1.10	1.07	<5	<5	4	5	<10	<10	5	5	<10	<10
Buffalo	N. Y.	1.18	1.16	<5	10	7	8	<10	10	<5	10	<10	<10
New York	N. Y.	1.14	1.15	<5	10	9	8	<10	30	5	15	<10	10
Syracuse	N. Y.	1.23	1.18	<5	15	7	7	<10	20	10	10	<10	10
Charlotte	N. C.	1.23	1.26	<5	5	12	11	<10	<10	5	10	<10	<10
Minot[b]	N. D.	—	1.08	—	<5	—	10	—	20	—	10	—	<10
Cincinnati	Ohio	1.18	1.22	<5	15	8	8	<10	20	<5	<5	<10	<10
Cleveland	Ohio	1.16	1.19	<5	10	8	7	<10	10	<5	5	<10	<10
Oklahoma City	Okla.	1.18	1.22	<5	15	8	7	<10	30	<5	5	<10	<10
Portland	Oreg.	1.12	1.08	<5	20	10	12	<10	20	20	20	<10	<10
Philadelphia	Pa.	1.17	1.21	<5	10	8	8	<10	10	10	10	<10	<10
Pittsburgh	Pa.	1.22	1.10	<5	10	12	10	<10	10	5	10	<10	<10
San Juan	P. R.	1.16	1.18	<5	15	4	4	<10	<10	<5	5	<10	<10
Providence	R. I.	1.21	1.19	<5	15	11	10	<10	10	10	25	<10	10
Charleston	S. C.	1.27	1.26	<5	<5	10	11	<10	10	5	20	<10	<10
Chattanooga	Tenn.	1.31	1.30	<5	15	10	11	<10	10	<5	10	<10	<10
Memphis	Tenn.	1.26	1.27	<5	15	10	11	<10	30	<5	5	<10	<10
Austin	Tex.	1.18	1.22	<5	10	2	3	<10	10	5	<5	<10	<10
Dallas	Tex.	1.23	1.23	<5	10	6	7	<10	10	<5	5	<10	<10
Salt Lake City	Utah	1.09	1.08	<5	5	5	5	<10	30	5	5	<10	<10
Burlington	Vt.	1.20	1.19	<5	10	9	8	<10	10	10	10	<10	<10
Norfolk	Va.	1.20	1.23	<5	15	9	9	<10	10	<5	10	<10	<10
Seattle	Wash.	1.09	1.07	<5	15	8	10	<10	20	30	15	<10	<10
Spokane	Wash.	1.09	1.07	<5	<5	7	8	<10	20	20	15	<10	<10
Charleston	W. Va.	1.19	1.08	<5	15	9	9	<10	<10	<5	5	<10	<10
Milwaukee	Wis.	1.17	1.19	<5	10	6	6	<10	20	<5	10	<10	<10
Laramie	Wyo.	1.06	1.05	<5	<5	5	6	<10	<10	10	10	<10	<10
Network average		1.16	1.14	<5	10	8	8	<10	20	10	10	<10	<10

[a] Averages based on 10 months' data or less.
[b] Dash indicates station not in operation during the year.
[c] Station began sampling after the resumption of atmospheric nuclear weapons testing. Sr^{90}, I^{131}, and Ba^{140} averages were calculated by assuming monthly concentrations for the period January–August 1961 were equal to zero.

of the United States. These figures show the increase of strontium–89 (half-life = 51 days) in pasteurized milk following the resumption of nuclear weapons testing in the atmosphere. They also show a reduction of strontium–89 in certain areas of the country where dairy cattle were fed during the winter on silage harvested prior to the resumption of atmospheric nuclear weapons testing.

Table 1 presents a summary of all available analyses for January 1962. These data are averages of weekly samples in most instances.

When a radionuclide was not detectable, one-half of the minimum level of detection was used for averaging.

Table 2 presents the 1960 and 1961 annual summaries. The 1960 averages are based on a maximum of 10 months' data since the first stations began sampling during March 1960. During most months of 1960, strontium–89, iodine–131, and barium–140 were not detectable. Therefore, the averages are indicated as being "less than" the minimum level of detection. During September, 1961, nuclear testing in the atmosphere was resumed, causing detectable concentrations of the short-lived nuclides, (strontium–89, iodine–131, and barium–140) to appear in pasteurized milk. The 1961 averages for strontium–89 (half-life, 51 days), Iodine–131 (half-life, 8.1 days), and barium–140 (half-life, 12.8 days), were calculated using zero for the concentrations during January through August 1961, and one-half of the minimum level of detection for the months in the period of September through December 1961, in which the radionuclide was not detectable. In some instances, September data were not used for averaging. The short-lived nuclides were not detected during the first half of September but were detected during the last half. For this reason the 1961 averages, for those stations which did not have a pasteurized milk sample analyzed during the last two weeks of September, were based on 11 months' data.

Radioactivity in Milk[1]

Health and Safety Laboratory
U.S. Atomic Energy Commission

In 1954, the Health and Safety Laboratory (HASL) began monitoring liquid whole milk in New York City for strontium–90 in order to estimate the potential hazard resulting from the contamination of foods by fallout. Subsequently, powdered milk monitoring was initiated at Mandan, North Dakota, and Perry, New York. Monitoring of liquid whole milk from two dairies in Honolulu, Hawaii, began in August 1959.

The New York City pasteurized liquid milk sample is a monthly composite of daily quart samples purchased in stores. Five large dairies are represented by purchases in rotation during the month. Weekly samples of pasteurized milk are collected from two dairies in Hawaii. Five-pound samples of powdered milk, collected from plants at Perry and Mandan, are composited at HASL on a monthly basis. The Perry sample is powdered whole milk for human consumption; the Mandan sample is powdered buttermilk used for cattle feed. The Honolulu samples are of interest since the cows are on pasture throughout the year and soil analyses have shown strontium–90 concentrations in soils in Hawaii comparable to those of the New York area.

Beginning September 1961, strontium–89 was measurable, indicating that fresh fission products from the USSR atmospheric nuclear weapons tests were being deposited. The Sr^{89}/Sr^{90} ratios are presented in table 1. The reduction in this ratio during December at Mandan can be attributed to the effect of winter silage harvested prior to the resumption of testing. Table 1 also presents the strontium–90 and calcium data for August–December 1961. Figures 1 and 2 show the fluctuations of strontium–90 concentrations with respect to time. [*Editor's note: Powdered milk when prepared for consumption contains approximately 0.1 kg milk powder per liter of liquid, therefore, the Perry powdered milk strontium–90 concentration during November 1961 would be about 4.6 μμc/liter.*]

[1] Data from Quarterly Summary Reports, *HASL–122*, April 1, 1962.

TABLE 1.—STRONTIUM-90 AND CALCIUM IN MILK SAMPLES, AUGUST–DECEMBER 1961

Sampling station and period	Calcium		Strontium-90			$\frac{Sr^{89}}{Sr^{90}}$
	gm/liter	gm/kg powder	μμc/liter	μμc/kg powder	μμc/gm Ca	
Perry, New York (powdered milk):						
1959 average					8.0	
1960 average					6.5	
August 1961		8.4		48	5.8	[a] 0
September		9.7		63	6.5	2.5
October		9.6		55	5.8	2
November		9.0		46	5.1	6
December		—		—	—	—
New York, New York (liquid milk):						
1959 average					11.0	
1960 average					8.0	
August 1961			5.4		5.4	0
September			5.2		5.2	0
October			6.0		6.0	12
November			6.1		6.1	4
December			5.7		5.7	1.5
Mandan, North Dakota (powdered buttermilk):						
1959 average					25.7	
1960 average					15.0	
August 1961		9.7		71	7.4	0
September		8.4		43	5.1	0
October		10.7		85	8.0	3
November		11.1		104	9.4	6
December		11.6		99	8.5	3
Honolulu, Hawaii[b] (liquid milk):						
1959 average					5.0	
1960 average					3.2	
August 1961					2.4	0
September					2.7	2
October					2.8	3.5
November					2.6	5.5
December					2.6	10

[a] Strontium-89 undetectable.
[b] Average of two dairies.

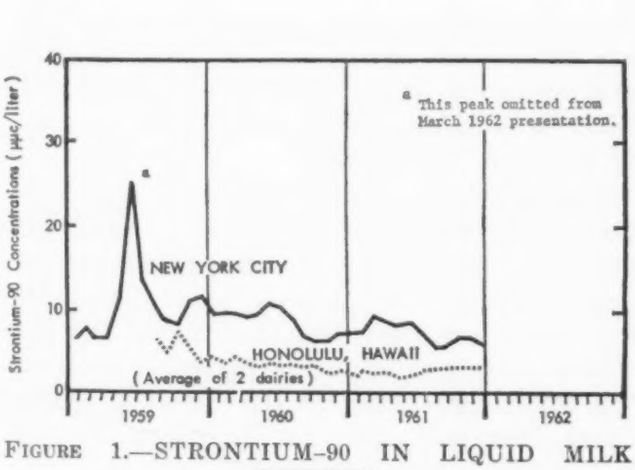

FIGURE 1.—STRONTIUM-90 IN LIQUID MILK SAMPLES

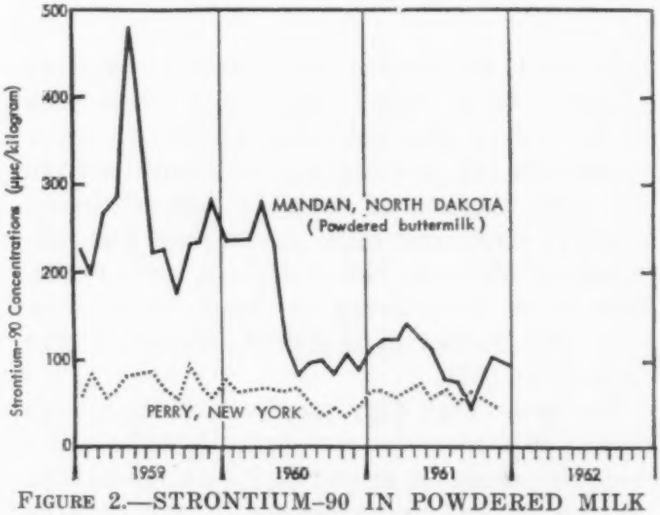

FIGURE 2.—STRONTIUM-90 IN POWDERED MILK SAMPLES

SECTION IV.—WATER

National Water Quality Network

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network operates under the provision of Section 4 (c) of the Federal Water Pollution Control Act, which states ". . . The Secretary shall . . . collect and disseminate basic data . . . (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local agencies and industrial organizations, commenced operations in October 1957. During December 1961, 95 sampling stations submitted water samples for analyses. These stations are located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial, and other uses. Some of these stations are on interstate, coastal, and international boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately, a total of approximately 300 stations will be in operation. Radioactivity is not yet being reported for a few of the more recently established stations.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids (strontium–90 on the total solids only) in raw surface water samples. The levels of radioactivity associated with dissolved solids provide a rough measure of the levels which may be found in treated water, where such water treatment removes substantially all of the suspended matter. Naturally-occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing for a period of three years, the beta activity in most raw waters generally had approached a level attributable solely to natural sources. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. The resumption of nuclear testing in the atmosphere by the U.S.S.R. has resulted in an increase in radioactivity of surface waters.

For the first two years of the Network operations, beta determinations were made on weekly samples. Alpha determinations were reported generally on composites of more than one weekly sample. Since January 1959, a portion of each sample from all stations in the Network has been composited into a three-

FIGURE 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, DECEMBER 1961

month sample for measurement of strontium–90 concentration.

Beginning January 1, 1960, the frequency of beta determinations varied depending on the status of each particular station. For the first operating year of each new station, analyses were being conducted weekly. Weekly analyses were to be continued indefinitely for all stations which may be affected by waste discharges from nuclear installations. Semimonthly determinations (on composites of 2 or 3 weekly samples) were conducted for stations which still showed some beta activity above background. Monthly determinations (on composites of all samples received from a station during the month) were conducted on samples from streams where beta activity was at background levels.

Beginning January 1, 1960, the frequency of alpha determinations also was changed. For the first operating year of each new station, analyses were to be done weekly. At some stations on the Colorado and Animas Rivers determinations were done on weekly samples or semimonthly on two- or three-week composites. The remainder of the stations were scheduled so that each made one gross alpha determination per month.

Following the resumption of nuclear weapons testing in the atmosphere by the U.S.S.R., the gross beta and alpha determination schedules were altered. Beginning September 1, 1961, gross beta determinations were made on all samples collected (compositing weekly samples for monthly or semimonthly gross beta or alpha determinations will cease). Beginning October 1, 1961, gross alpha determinations were made on one sample from each station each month, unless there is evidence of alpha activity in excess of background levels. In the latter instance, an alpha determination were made on a weekly or bi-weekly basis, depending on what is considered the norm for a particular station.

All data reported in table 1 represent the average of all data reported for the period indicated. The reported strontium–90 data are the results of determinations on three-month

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Average concentrations in μμc/liter]

Station	Quarter ending Sept. 30, 1961	December 1961					
	Strontium-90	Beta activity			Alpha activity		
	Total	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa.	0.3	—	—	—	—	—	—
Animas River: Cedar Hill, N. Mex.	0.3	22	32	54	4	10	14
Apalachicola River: Chattahoochie, Fla.	0.4	1	4	5	0	0	0
Arkansas River:							
Coolidge, Kansas	2.3	20	89	109	4	42	46
Ponca City, Okla.	[a]—	45	61	106	0	0	0
Pendleton Ferry, Ark.	—	37	34	71	—	—	—
Big Horn River: Hardin, Mont.	—	8	27	35	1	10	11
Big Sioux River: Sioux Falls, S. Dak.	0.4	18	58	76	<1	<1	1
Chattahoochie River:							
Atlanta, Ga.	—	16	13	29	0	0	0
Columbia, Ga.	—	15	14	29	0	0	0
Clear Water River: East Lewiston, Idaho	—	29	33	62	0	<1	<1
Colorado River:							
Loma, Colo.	—	26	40	66	3	9	12
Boulder City, Nev.	1.0	4	22	26	<1	8	8
Parker Dam, Calif.	—	6	24	30	0	6	6
Yuma, Ariz.	—	11	40	51	3	1	4
Columbia River:							
Wenatchee, Wash.	—	3	7	10	0	1	1
Pasco, Wash.	1.1	104	678	782	—	—	—
Bonneville Dam, Oreg.	[b] 0.6	29	423	452	—	—	—
Clatskanie, Oreg.	—	27	74	101	0	0	0
McNary Dam, Oreg.	1.2	198	331	529	0	1	1
Connecticut River:							
Northfield, Mass.	0.4	9	15	24	—	—	—
Wilder, Vt.	—	13	23	36	0	0	0
Cumberland River: Clarksville, Tenn.	0.4	48	28	76	1	0	1
Delaware River:							
Martins Creek, Pa.	—	13	22	35	0	0	0
Trenton, N. J.	—	24	22	46	0	0	0
Escambia River: Century, Fla.	[b] 0.9	13	14	27	0	0	0
Great Lakes:							
Buffalo, N. Y.	—	12	10	22	1	0	1
Detroit, Mich.	[b] 0.6	7	13	20	0	0	0
Port Huron, Mich.	0.4	1	4	5	0	0	0
Milwaukee, Wis.	—	3	9	12	0	1	1
Sault Ste. Marie, Mich.	—	4	5	9	0	1	1
Gary, Ind.	0.2	10	12	22	0	0	0
Duluth, Minn.	—	3	3	6	0	0	0
Hudson River: Poughkeepsie, N. Y.	0.2	15	17	32	—	—	—
Illinois River:							
Peoria, Ill.	0.4	28	26	54	1	0	1
Grafton, Ill.	—	48	24	72	8	1	9
Kanawha River: Winfield Dam, W. Va.	—	34	11	45	0	0	0
Klamath River: Copco, Oreg.	—	31	22	53	0	0	0
Little Miami River: Cincinnati, Ohio	1.1	48	50	98	<1	0	<1
Merrimack River: Lowell, Mass.	[b] 0.7	19	24	43	0	0	0
Mississippi River:							
St. Paul, Minn.	0.9	18	31	49	0	1	1
Dubuque, Iowa	—	10	22	32	0	2	2
Burlington, Iowa	0.6	11	16	27	4	0	4
E. St. Louis, Ill.	—	36	34	70	0	1	1
Cape Girardeau, Mo.	0.8	22	26	48	0	2	2
West Memphis, Ark.	—	55	31	86	6	1	7
Delta, La.	[b] 0.4	148	29	177	—	—	—
New Orleans, La.	—	59	38	97	20	1	21
Vicksburg, Miss.	—	63	34	97	3	<1	3
Missouri River:							
Williston, N. Dak.	—	3	19	22	—	—	—
Bismarck, N. Dak.	—	<1	13	13	—	—	—
Yankton, S. Dak.	0.6	4	19	23	1	4	5
Omaha, Nebr.	—	3	28	31	1	2	3
St. Joseph, Mo.	—	11	26	37	0	5	5
Kansas City, Kan.	—	24	23	47	1	1	2
St. Louis, Mo.	1.4	33	40	73	2	2	4
Monongahela River: Pittsburgh, Pa.	0.4	12	15	27	1	<1	1
North Platte River: Henry, Nebr.	—	18	52	70	0	30	30
Ohio River:							
East Liverpool, Ohio	0.4	—	—	—	—	—	—
Huntington, W. Va.	—	18	14	32	0	0	0
Cincinnati, Ohio	—	19	15	34	1	0	1
Louisville, Ky.	0.4	18	17	35	1	0	1
Evansville, Ind.	—	16	17	33	3	0	3
Cairo, Ill.	1.1	—	—	—	—	—	—
Ouchita River: Bastrop, La.	—	48	66	114	<1	0	<1
Potomac River:							
Williamsport, Md.	—	14	16	30	0	0	0
Great Falls, Md.	—	14	28	42	—	—	—
Platte River: Plattsmouth, Nebr.	—	12	30	42	<1	8	8
Rainy River:							
International Falls, Minn.	—	4	16	20	0	0	0
Red River, South:							
Index, Ark.	—	87	54	141	3	1	4
Denison, Tex.	—	7	20	27	—	—	—
Alexandria, La.	1.0	84	28	112	13	1	14

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Average concentrations in μμc/liter]

Station	Quarter ending Sept. 30, 1961	December 1961					
	Strontium-90	Beta activity			Alpha activity		
	Total	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Rio Grande River:							
Alamosa, Colo	[b] 0.4	—	—	—	—	—	—
Laredo, Tex	—	9	23	32	0	7	7
Brownsville, Tex	—	21	32	53	1	2	3
Roanoke River: John H. Kerr Reservoir and Dam, Va	—	10	11	21	0	0	0
Sabine River: Ruliff, Tex	—	33	38	71	—	—	—
San Juan River: Shiprock, N. Mex	—	5	38	43	1	13	14
St Lawrence River: Massena, N. Y	—	4	16	20	0	0	0
Schuylkill River: Philadelphia, Pa	—	25	30	55	2	1	3
Savannah River:							
Port Wentworth, Ga	0.4	18	27	45	0	0	0
North Augusta, S. C	—	10	10	20	0	0	0
Shenandoah River: Berryville, Va	—	21	25	46	<1	0	<1
Snake River:							
Wawawai, Wash	0.3	10	22	32	0	2	2
Payette, Idaho	—	10	25	35	0	3	3
South Platte River: Julesburg, Colo	0.7	9	67	76	2	36	38
Susquehanna River:							
Sayre, Pa	0.3	13	15	28	<1	<1	1
Conowingo, Md	0.3	11	25	36	0	0	0
Tennessee River:							
Pickwick Landing, Tenn	—	14	33	47	<1	0	<1
Chattanooga, Tenn	0.6	54	54	108	4	0	4
Bridgeport, Ala	0.7	15	50	65	0	0	0
Tombigbee River: Columbus, Miss	—	166	42	208	2	0	2
Truckee River: Farad, Calif	—	5	15	20	<1	<1	1
Yakima River: Richland, Wash	0.4	9	13	22	0	2	2
Yellowstone River: Sidney, Mont	—	3	21	24	—	—	—

[a] Dash denotes no sample received or no determination made.
[b] April–September strontium-90 data.

composite samples for the quarter ending in the month shown.

Additional information and data may be obtained from the following sources:

(1) *National Water Quality Network Annual Compilation of Data*, PHS Publication No. 663, Water Years 1957–58, 1958–59, 1959–60. Public Health Service, Division of Water Supply and Pollution Control, Washington 25, D. C.

(2) "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167–169.

(3) Setter, L. R., J. E. Regnier, and A. Diephaus, "Radioactivity of Surface Waters in the United States," *Journal of the American Water Works Association*, 51, 1377 (1959).

(4) Straub, C. P., L. R. Setter, A. Goldin, and P. F. Hallbach, "Strontium–90 in Surface Waters," *Journal of the American Water Works Association*, 52, 756 (1960).

(5) Setter, L. R., and S. L. Baker, "Radioactivity of Surface Waters in the United States," *Radiological Health Data*, Vol. I, No. 7 (1960).

(6) Straub, C. P., "Significance of Radioactivity Data," *Journal of the American Water Works Association*, *53*, 704 (1961).

Monitoring of Water Supplies Around the Nevada Test Site

U.S. Atomic Energy Commission

By contract with the Atomic Energy Commission, the Public Health Service has conducted an offsite monitoring program around the Nevada Test Site (NTS) since 1955. This program includes sampling of air, water, and milk. Figures 1 and 2 summarize the gross beta measurements in water supplies located in the NTS offsite area for July–October 1961. The gross beta measurements are shown as numbers placed beside the sampling sites on

FIGURE 1.—GROSS BETA ACTIVITY IN WATER SUPPLIES IN OFF-SITE AREAS OF THE NEVADA TEST SITE, JULY AND AUGUST 1961

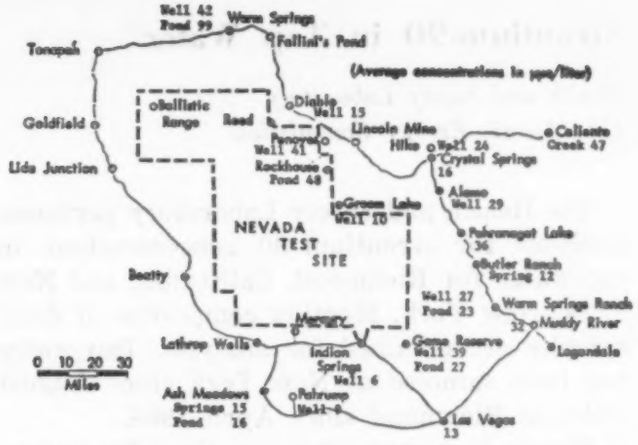

FIGURE 2.—GROSS BETA ACTIVITY IN WATER SUPPLIES IN OFF-SITE AREAS OF THE NEVADA TEST SITE, SEPTEMBER AND OCTOBER 1961

figures 1 and 2. The lower limit of detection with the equipment used is about 10 μμc/liter.

All locations listed in table 1 are not sampled each month, but on a rotation basis so that in any given yearly period the necessary information is available to adequately describe the background radiation situation in the offsite area. During an operational period, intensive monitoring occurs in those areas affected. These data are published in special reports by the Atomic Energy Commission.

The highest gross beta concentration in water for July and August 1961 was 155 μμc/liter at Fallini's Pond on August 15. While this is higher than usual, it is still essentially background. The increase can probably be attributed to the comparatively heavy rains preceding the sample pickup. During the period September and October, the highest concentration was from the pool at Warm Springs on October 11, which was also essentially background.

Previous coverage in *Radiological Health Data:*

Period	*Issue*
November–December 1959	April 1960
January–April 1960	September 1960
May–June 1960	November 1960
July–August 1960	January 1961
September–December 1960	May 1961
January–February 1961	June 1961
March–June 1961	November 1961

TABLE 1.—DESCRIPTION OF WATER SAMPLING POINTS, NEVADA TEST SITE

Location	Source	Population served
Las Vegas	13 wells—650 to 1,250″ depth plus Lake Mead supply	40,000.
Game Reserve	400′ drilled well	20.
Indian Springs	600′ drilled well	Average 250.
Pahrump	75′ driven well	10–50.
Ash Meadows	Spring 25′ deep	8.
Lathrop Wells	3 wells—600′ deep	Average 15.
Beatty	Spring	550.
Lida Junction	125′ drilled well	2–10.
Goldfield	Spring	Average 200.
Tonopah	2 drilled wells—60′ depth	Average 1,500.
Warm Springs	Multiple springs—no improvement	10.
Diablo	Well	State Highway Station.
Lincoln Mine	2 driven wells	3.
Caliente	Springs	Average 10–12.
Crystal Springs	Free flowing spring	0.
Alamo	2 wells—50–67′ deep	Average 175.
Pahranagat Lake	Surface	Not used for domestic purposes.
Butler Ranch	Flowing spring	1.
Warm Spring Ranch	Flowing spring from earth fault	Public park with swimming pool.
Logandale	Drilled well	300.
Ballistic Range	Drilled well	10–15.

Strontium-90 in Tap Water[1]

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory performs analyses for strontium–90 concentrations in tap water for Richmond, California, and New York, New York. Monthly composites of daily samples are obtained for analysis. Tap water has been sampled at New York since August 1954, at Richmond since April 1958.

Figure 1 presents the strontium–90 concentrations in tap water from 1958. Data prior to 1958 appear in "Environmental Contamination from Weapons Tests," *HASL–42A*, June 16, 1958. Table 1 presents third and fourth quarter monthly averages for 1961, and averages for 1959 and 1960.

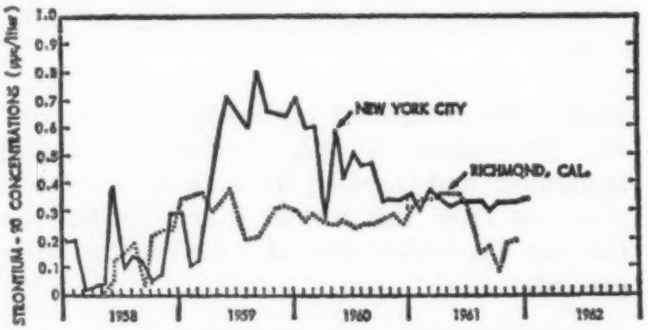

FIGURE 1.—STRONTIUM–90 CONCENTRATIONS IN TAP WATER

TABLE 1.—STRONTIUM-90 IN TAP WATER, THIRD AND FOURTH QUARTERS, 1961

Location	Month	Strontium-90 (μμc/liter)	$\frac{Sr^{89}}{Sr^{90}}$
Richmond, California (40 liters per sample)	Average 1959	0.29	
	Average 1960	0.26	
	July 1961	0.31	
	August	0.14	
	September	0.16	0.7
	October	0.08	0
	November	0.18	1.0
	December	0.19	7.4
New York, New York (100–200 liters per sample)	Average 1959	0.40	
	Average 1960	0.47	
	July 1961	0.30	
	August	0.34	
	September	0.19	0
	October	0.31	1.6
	November	0.30	7.2
	December	0.34	6.5

[1] Data from *Quarterly Summary Report, HASL* 122, April 1, 1962.

SECTION V.—OTHER DATA

External Gamma Activity

Division of Radiological Health, Public Health Service

Daily measurements of external gamma radiation are made at stations of the Radiation Surveillance Network to assure detection of any substantial deviations from normal background levels. Portable geiger-mueller survey instruments are used to obtain measurements at three feet above the ground surface. March 1962 data reported in table 1 are characteristic of individual station observations which in recent years have defined the range of normal background values.

TABLE 1.—EXTERNAL GAMMA ACTIVITY, MARCH 1962

Station location		Average (mr/hr)	Station location		Average (mr/hr)
City	State		City	State	
Adak	Alaska	0.01	Winchester	Mass	0.02
Anchorage	Alaska	0.01	Lansing	Mich	0.02
Attu	Alaska	0.01	Minneapolis	Minn	0.01
Cold Bay	Alaska	0.01	Jackson	Miss	0.01
Fairbanks	Alaska	0.01	Pascagoula	Miss	—
Juneau	Alaska	0.01	Jefferson City	Mo	0.01
Kodiak	Alaska	0.01	Helena	Mont	0.03
Nome	Alaska	0.01	Lincoln	Nebr	0.01
Point Barrow	Alaska	0.01	Trenton	N. J	0.02
St. Paul Island	Alaska	[a]—	Santa Fe	N. Mex	0.05
Phoenix	Ariz	0.02	Albany	N. Y	0.03
Little Rock	Ark	0.01	Buffalo	N. Y	0.01
Berkeley	Calif	0.01	New York	N. Y	—
Los Angeles	Calif	—	Gastonia	N. C	0.02
Denver	Colo	0.02	Bismarck	N. D	0.01
Hartford	Conn	0.01	Columbus	Ohio	0.01
Washington	D. C	0.02	Oklahoma City	Okla	0.02
Jacksonville	Fla	0.01	Ponca City	Okla	0.04
Miami	Fla	0.01	Portland	Oreg	0.02
Atlanta	Ga	0.02	Harrisburg	Pa	0.01
Agana	Guam	—	San Juan	P. R	—
Honolulu	Hawaii	0.05	Providence	R. I	0.02
Boise	Idaho	0.02	Columbia	S. C	0.02
Springfield	Ill	0.01	Pierre	S. D	0.02
Indianapolis	Ind	0.01	Nashville	Tenn	0.01
Iowa City	Iowa	0.01	Austin	Tex	0.01
Topeka	Kans	0.02	El Paso	Tex	0.02
Frankfort	Ky	0.01	Salt Lake City	Utah	0.02
New Orleans	La	0.02	Richmond	Va	0.01
Augusta	Maine	0.02	Seattle	Wash	0.02
Presque Isle	Maine	0.02	Madison	Wis	0.02
Baltimore	Md	0.02	Cheyenne	Wyo	0.02
Lawrence	Mass	0.02	Sundance	Wyo	—

[a] Dash indicates no data received.

Observed Concentrations of Iodine-131 in Human Thyroids

Division of Radiological Health, Public Health Service

Following the U.S.S.R. resumption of atmospheric nuclear testing on September 1, 1961, iodine–131 was first reported in the milk supply of the United States on September 19, 1961. It was first reported to the Division of Radiological Health to be present in human thyroids in New York City by Dr. M. Eisenbud of New York University, New York, N. Y., on October 10, 1961.(*1*)

A joint program was started with the following participants:

Armed Forces Institute of Pathology
Walter Reed Army Medical Center
Washington, D. C.

University of Arkansas
Little Rock, Arkansas

Tulane University
New Orleans, Louisiana

Division of Radiological Health
Public Health Service
Washington, D. C.

Between October 18, 1961 and February 1, 1962, the three participating medical centers supplied a total of 101 thyroids to the Radiological Health Laboratory at Rockville, Maryland. The intent was to examine thyroids of individuals who could have expected to have been taking a "normal diet" within two weeks of their death. Almost all were sudden deaths, usually from physical trauma.

Dissections were performed within a few hours after death by a pathologist and the specimens, with a dilute formalin preservative, were airmailed to the laboratory. The thyroids were then weighed and kept under refrigeration until counted. In some cases the thyroids were weighed and counted the same day as received; in others they were placed in a container and counted the following day. The gamma emissions of the specimens were counted for 100 minutes on a 4″ x 4″ sodium iodide (thallium) crystal and recorded by a pulse height analyser. The counts were simultaneously recorded on a print out and also on punched tape. The print out was used for the calculation of iodine–131 present in the thyroid specimen.

The assumption made in the calculation of the amount of iodine–131 present in thyroids was that identical counting conditions are found when counting a solution in a one ounce bottle. This assumption contained two factors, the geometry factor which was visually comparable and the absorption factor which would seem to be comparable since the density of the thyroid is approximately one. The counts considered to be due to iodine–131 were those found in the energy range of 0.3 Mev to 0.42 Mev and yet greater then the background in this energy region. Under these conditions the efficiency for counting iodine–131 was calculated to be 5.8 percent. Thus the equation for the amount of iodine per gram of thyroid is as follows:

$$\mu\mu c\ I^{131}/gm = \frac{\text{(Counts due to } I^{131})}{\text{(2.22 dpm/}\mu\mu c\text{) (0.058) (time of count) (gm of thyroid)}}$$

Iodine–131 content determined at time of counting was then extrapolated back to time of death using the half life of eight days. The data is presented in table 1.

REFERENCE

(*1*) Eisenbud, M., Y. Mochizuki, A. S. Goldin, and G. R. Laurer, "Iodine–131 Dose from Soviet Nuclear Tests," Science, Vol. 136, No. 3514, pp 370–374 (May 4, 1962).

TABLE 1.—IODINE-131 CONCENTRATIONS IN HUMAN MALE THYROIDS OCTOBER 1961–JANUARY 1962

Date of death	Location	Age (years)	Total thyroid weight (grams)	Iodine-131 ($\mu\mu$c/gm thyroid)	Date of death	Location	Age (years)	Total thyroid weight (grams)	Iodine-131 ($\mu\mu$c/gm thyroid)
October 18	Louisiana	47	8.8	[a] ND	November 13	Unknown	20	16.6	ND
October 21	Unknown	26	11.3	ND	November 13	Spain	26	14.1	4
October 23	Germany	21	15.8	[b] 70	November 13	Spain	22	18.2	3
October 24	Alaska	27	30.3	21	November 19	Okinawa	59	15.4	9
October 24	Germany	19	15.4	ND	November 25	Germany	26	24.5	ND
October 25	Louisiana	65	17.9	ND	November 29	Unknown	20	8.2	ND
October 26	Puerto Rico	26	11.3	ND	November 30	Korea	Adult	14.9	ND
October 25	Unknown	31	20.3	ND	November 30	Korea	Adult	33.2	ND
October 26	Germany	25	28	ND	November 30	Okinawa	19	9.9	ND
October 27	California	5	3.38	30	December 1	Germany	22	15.5	2
October 28	Washington	29	14.9	730	December 3	Colorado	18	15.2	8
October 28	Germany	23	13.1	20	December 3	Germany	23	14.6	4
October 29	Germany	24	25.4	ND	December 3	Europe	1½	3.5	ND
October 29	Korea	22	10.8	ND	December 3	Europe	40	27.5	ND
October 30	Louisiana	52	16.8	8	December 9	Pacific	44	30.2	2
October 31	Korea	42	96	ND	December 9	Pacific	40	11.7	ND
October 31	Korea	21	18	ND	December 10	Korea	28	24.0	2
November 1	Germany	19	23.7	ND	December 11	Korea	23	21.7	2
November 1–15	Unknown	—	14.1	ND	December 11	Korea	39	12.6	ND
November 1–15	Unknown	—	18.4	ND	December 11	Unknown	31	13.6	ND
November 1–15	Unknown	—	30.7	ND	December 11	Washington	—	15.1	ND
November 1–15	Unknown	—	21.7	ND	December 21	Germany	25	34.0	2
November 1–15	Unknown	—	19.5	ND	December 28	Germany	36	23.5	ND
November 1–15	Unknown	—	18.3	ND	January 1–7	Japan	20	13.5	ND
November 1–15	Unknown	—	20.1	ND	January 3	Germany	26	25.2	ND
November 1–15	Unknown	—	29.0	ND	January 3	Germany	—	7.9	ND
November 1–15	Unknown	—	11.2	ND	January 3	Unknown	37	14.0	ND
November 1–15	Unknown	—	21.0	ND	January 3	Germany	20	25.4	2
November 1–15	Unknown	—	21.0	2	January 3	Unknown	4	3.4	ND
November 2	Korea	19	13	ND	January 3	Unknown	47	37.5	ND
November 2	Germany	44	23.8	ND	January 4	Korea	41	10.9	ND
November 3	Germany	Adult	15.1	2	January 4	Unknown	23	19.9	ND
November 3	Japan	37	17.7	2	January 5	Germany	41	37.3	ND
November 5	Germany	32	30	5	January 6	Germany	41	26.2	ND
November 6	Arkansas	3 months	2.5	ND	January 7	Puerto Rico	23	23.3	ND
November 6	Germany	20	18	12	January 8	Germany	30	17.0	ND
November 8	Unknown	33	23.8	ND	January 9	Korea	38	38.3	ND
November 10	Arkansas	27	22.5	2	January 9	Korea	22	35.7	2
November 10	Unknown	—	14	3	January 9	Korea	Adult	22.0	2
November 10	Unknown	21	28.8	ND	January 10	Germany	31	20.2	2
November 10	Unknown	24	13.6	10	January 18	Germany	21	23.7	ND
November 11	Unknown	26	20.5	ND	January 20	Japan	8	7.7	ND
November 12	Germany	20	21.2	ND	January 23	Germany	19	13.4	ND
November 12	Germany	41	23.6	ND	January 23	Germany	21	18.5	ND
November 13	Colorado	32	18.6	ND	January 25	Germany	11 months	2.1	[c] ND
November 13	Germany	41	15.6	ND	January 26	Germany	48	13.6	ND
November 13	Unknown	25	18	7	January 28	Korea	54	18.5	ND
November 13	Unknown	5	3.8	5					
November 13	Unknown	6 months	2	ND					
November 13	Germany	19	14.0	ND					

[a] ND indicates concentration was non-detectable. Non-detectable for most samples was about 5 $\mu\mu$c/gm.
[b] Inquiry underway.
[c] Female.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission receives from its contractors quarterly reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Various summaries of the environmental radioactivity data for 18 AEC installations have appeared in *Radiological Health Data* since November 1960. Summaries follow for Brookhaven National Laboratory, Mound Laboratory, and National Reactor Testing Station, covering the third and fourth quarters of 1961.

The measured concentration of a radio-

TABLE 1.—SELECTED ENVIRONMENTAL VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line no.	Radionuclide or mixture of radionuclides	Environmental MPC's	
		Water ($\mu\mu$c/liter)	Air ($\mu\mu$c/m^3)
1	If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, Ra^{223}, Ra^{226}, Ra^{228}, Pa^{231}, and Th-nat are not present[a]	2,000	—
2	If Sr^{90}, Pb^{210}, Ra^{226}, Ra^{228} are not present[a]	600	—
3	If Ra^{226}, Ra^{228} are not present[a]	100	—
4	Mixture of unidentified nuclides	10	0.04
5	If α emitters and Ac^{227} are not present[a]	—	1.0
6	If α emitters and Pb^{210}, Ac^{227}, Ra^{228}, and Pu^{241} are not present[a]	—	10.0
7	If α emitters and Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, and Bk^{249} are not present[a]	—	100
8	Hydrogen-3 (tritium)	3,000,000	200,000
9	Iodine-131	2,000	200
10	Plutonium-239	5,000	0.06
11	Polonium-210	700	20
12	Strontium-90	100	10

[a] "Not present" implies that the concentration of the nuclide is small compared with its appropriate MPC. According to recent AEC regulation (*Federal Register*, Title 10, Part 20, August 9, 1961), a group of nuclides may be considered not present if the ratio of each nuclide to its appropriate MPC is equal to or less than 1/10 and if the sum of these ratios for the group in question is equal to or less than 1/4.

nuclide in air and water may be compared with the Maximum Permissible Concentration (MPC) of that nuclide as recommended by the National Committee on Radiation Protection and Measurement (NCRP). For the environment near an AEC installation, the applicable MPC's are one-tenth of the occupational MPC values for continuous exposure given in National Bureau of Standards "Handbook 69."

To avoid any possible misunderstandings in the use of the term "Maximum Permissible Concentrations," the Federal Radiation Council (FRC) has recommended the term "Radioactivity Concentration Guide (RCG) for the use of Federal Agencies. Although FRC has not published a table of RCG values, several AEC installations such as National Reactor Testing Station, have adopted FRC nomenclature but use the NCRP published values. For a more detailed description of the meaning and use of the RCG, the reader is referred to FRC Report No. 2.[1]

For purposes of clarity and perspective, a few of the applicable environmental MPC values for nuclides or mixtures of unknown nuclides are listed in table 1. Such values are intended as guides only. For further clarification, "Handbook 69" should be consulted.

The establishment of MPC's does not imply that each nuclide may be permitted to be present at 100% of its MPC concentration. If the concentration of each nuclide is expressed in terms of percent of its MPC, the sum of all the percent values should not exceed 100%.

In the following reports, the use of nonspecific terms such as "total activity," "total alpha," and "gross beta" do not in themselves suggest any one MPC value. Often, when concentrations are low a laboratory will assign an MPC value that is more restrictive than necessary. This avoids the more costly isotopic tests necessary to justify a less restrictive value. References in table 1 will be made to designate the appropriate MPC's reported by the laboratories.

[1] Federal Radiation Council Report No. 2, "Background Material for the Development of Radiation Protection Standards," Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 20 cents.

PRINT IN BINDIN

Brookhaven National Laboratory

Associated Universities, Inc.
Upton, New York

Third and Fourth Quarters 1961

The Brookhaven National Laboratory (BNL) operations affect the environmental levels of radiation in two ways: (1) by discharge of coolant air from the graphite research reactor, and (2) by the discharge of low level radioactive liquid wastes into a small stream that forms one of the head waters of the Peconic River.

Air Monitoring

The radioactivity in the discharge coolant air is almost entirely that of argon–41, a beta-gamma emitter. Because the most critical exposure to argon–41 is that of external gamma, the monitoring is performed by measuring the dose-rate in milliroentgens per week (mr/wk) rather than the concentration in air. The environmental maximum permissible dose recommended by NCRP is 0.5 r/yr (10 mr/wk) above natural background, averaged over a one year period.

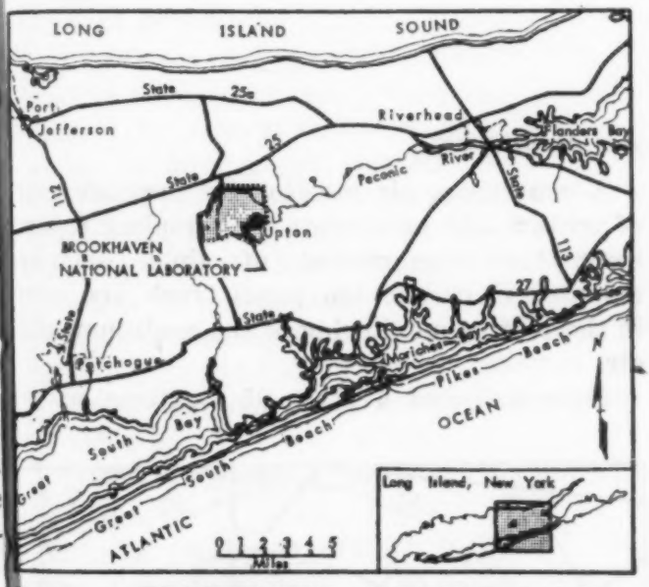

FIGURE 1.—BROOKHAVEN NATIONAL LABORATORY AND SURROUNDING AREA

Table 2 presents the average external gamma dose rates measured at the four stations shown in figure 2.

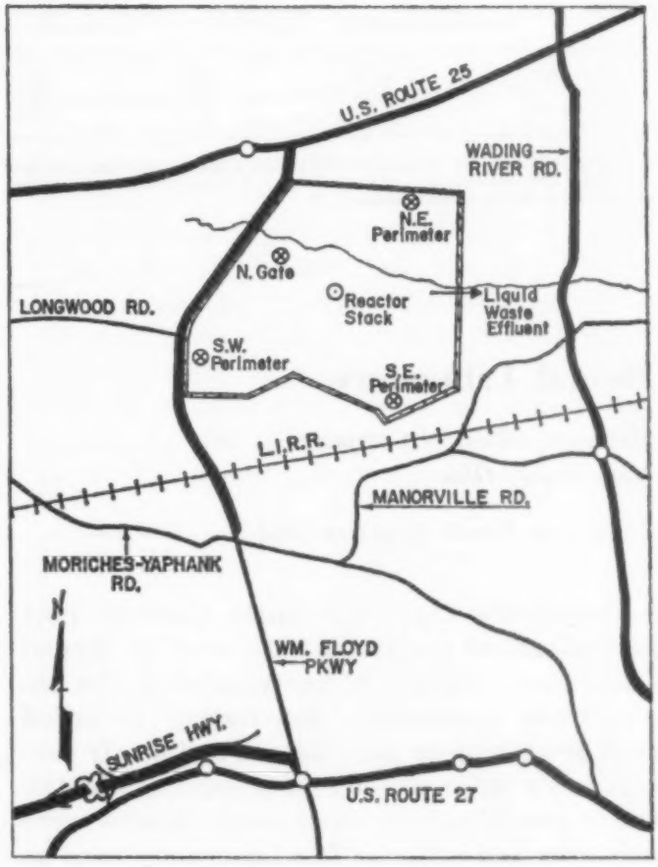

FIGURE 2.—BROOKHAVEN NATIONAL LABORATORY MONITORING STATIONS LOCATIONS

TABLE 2.—EXTERNAL GAMMA LEVELS AT BNL SITE BOUNDARY, 1961

[Average dose rates in mr/week]

Period-1961	North gate	Southwest perimeter	Southeast perimeter	Northeast perimeter
Gamma from laboratory operations:[1]				
First quarter[2]	0.30	0.43	0.90	0.40
Second quarter[2]	0.68	0.44	0.47	1.55
Third quarter	0.66	0.73	0.28	0.92
Fourth quarter	0.38	0.35	0.77	0.46
Calendar year	0.50	0.49	0.60	0.83
Dose rate from undisturbed background:				
Third quarter	2.09	2.07	2.05	1.81
Fourth quarter	2.57	2.33	2.51	2.74

[1] Gamma dose from laboratory operation is due almost entirely to argon-41 from the reactor cooling air.

[2] The first and second quarters have been included here to amend the data reported in January 1962 *Radiological Health Data*, page 24, table 2, which erroneously showed the peak weekly averages instead of the quarterly averages.

IN BINDING

TABLE 3.—GROSS BETA ACTIVITY IN LIQUID WASTE EFFLUENT, BNL, 1961

Period—1961	Average effluent flow rate (million gallons/day)	Average beta concentration[1] ($\mu\mu$c/liter)	Total beta activity discharged (millicuries)
Third quarter	1.004	180	64.8
Fourth quarter	0.705	140	31.7
Calendar year	0.908	170	192.9

[1] The MPC used by the plant for this stream is 500 $\mu\mu$c/liter based on the knowledge that less than 20% of the activity is Sr^{90} and that no appreciable amount of radium is present (see table 1).

Water Monitoring

The BNL liquid waste effluent is monitored for gross beta concentrations at the site boundary. Table 3 presents the average concentration together with the total activity released as determined by using known effluent flow rates.

Previous coverage in *Radiological Health Data*

Period	Issue:
1959 and first quarter 1960	December 1960
Second quarter 1960	February 1961
Third and fourth quarters 1960	June 1961
First and second quarters 1961	January 1962

Mound Laboratory

Monsanto Chemical Company
Miamisburg, Ohio

Third and Fourth Quarters 1961

During the third and fourth quarters 1961 no radioactive materials were used by Mound Laboratory (ML) that contributed to the environment measurable penetrating radiation such as gamma or hard beta. Possible air contaminants were plutonium, polonium, and tritium; possible river water contaminants were polonium and tritium. The Laboratory uses as its guides the environmental MPC's as determined from NBS "Handbook 69" (see table 1).

Air Monitoring

A continuous air monitor for measurement of tritium and particulate air sampling equipment for measurement of alpha activity mounted on a one ton panel truck are used in the routine monitoring of the environmental air.

Figures 3 and 4 show 95 locations up to

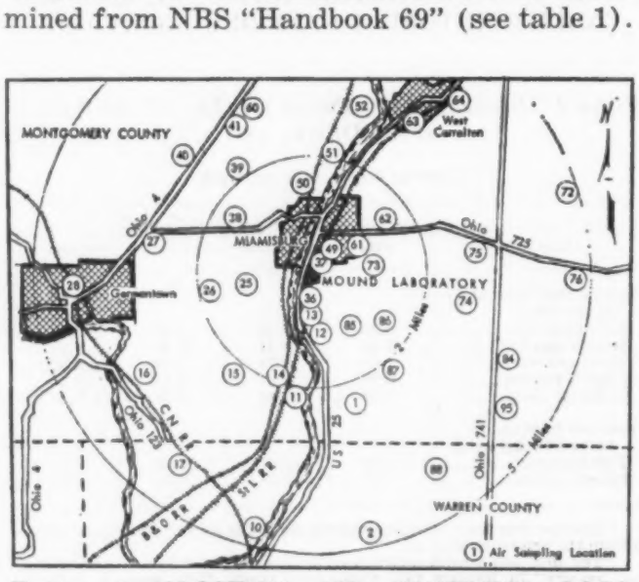

FIGURE 3.—CLOSE-IN AIR SAMPLING LOCATIONS, MOUND LABORATORY

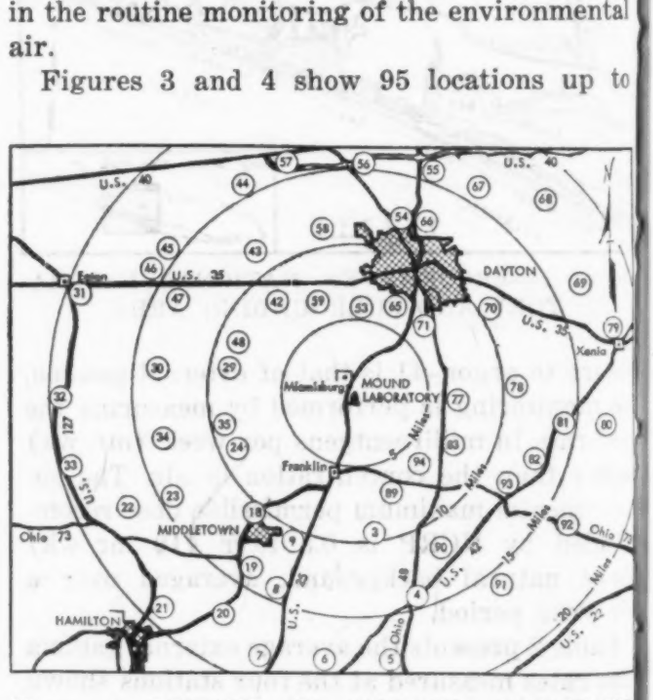

FIGURE 4.—DISTANT AIR SAMPLING LOCATIONS, MOUND LABORATORY

TABLE 4.—DISTANCE EFFECT ON LONG-LIVED ALPHA CONCENTRATIONS IN AIR, ML, 1961

Sampling locations zone (distance in miles from laboratory)	Third quarter 1961		Fourth quarter 1961	
	No. of samples	Average concentration ($\mu\mu c/m^3$)	No. of samples	Average concentration ($\mu\mu c/m^3$)
0–2	26	0.015	27	0.024
2–5	39	0.010	41	0.012
5–10	22	0.020	25	0.008
10–15	30	0.013	29	0.021
15–20	38	0.011	34	0.051

20 miles from the laboratory at which air samples are taken. The selection of sampling sites depends on the wind direction on the days that samples are collected. Samples are collected downwind from the plant according to routes drawn up for the different wind directions. It is quite likely that not all sites will be sampled during any one quarter.

A total of 310 samples were taken for determination of tritium in air during the third and fourth quarters, 1961. In all cases the tritium concentration was below the minimum level of detection.

Monitoring for possible polonium and plutonium released to the environment is accomplished by determination of long-lived gross alpha on filter paper samples. Counting was done in a low background proportional counter after sufficient time had elapsed after collection to permit the decay of short-lived daughter products of radon and thoron. The average alpha concentrations in air at different distances from the Laboratory are given in table 4. An upwind-downwind comparison is shown in table 5.

If all the alpha activity were assumed to be polonium it would be about 0.05% of the MPC for polonium as given in table 1. However, polonium effluent stack monitoring indicated that no detectable polonium should be found in the environment due to the operations of Mound Laboratory.

If the alpha activity were assumed to be all plutonium, it would amount to a much more significant 15 percent of the MPC for plutonium. Again the stack monitoring results are quite meaningful. The average concentration of plutonium in the air discharged from the plutonium stack was well within environmental limits. For this reason, and the fact that the air is discharged to the environment from the 200–foot stack at high velocity yielding appreciable dilution, it is seen that the plutonium operations have contributed an insignificant burden to the radioactivity normally present in the atmosphere. It is also pointed out that

TABLE 5.—WIND EFFECT ON LONG-LIVED ALPHA CONCENTRATIONS IN AIR, ML, 1961

Direction from laboratory relative to wind	Third quarter		Fourth quarter	
	No. of samples	Alpha ($\mu\mu c/m^3$)	No. of samples	Alpha ($\mu\mu c/m^3$)
Upwind	24	0.009	24	0.016
Downwind	155	0.012	159	0.025

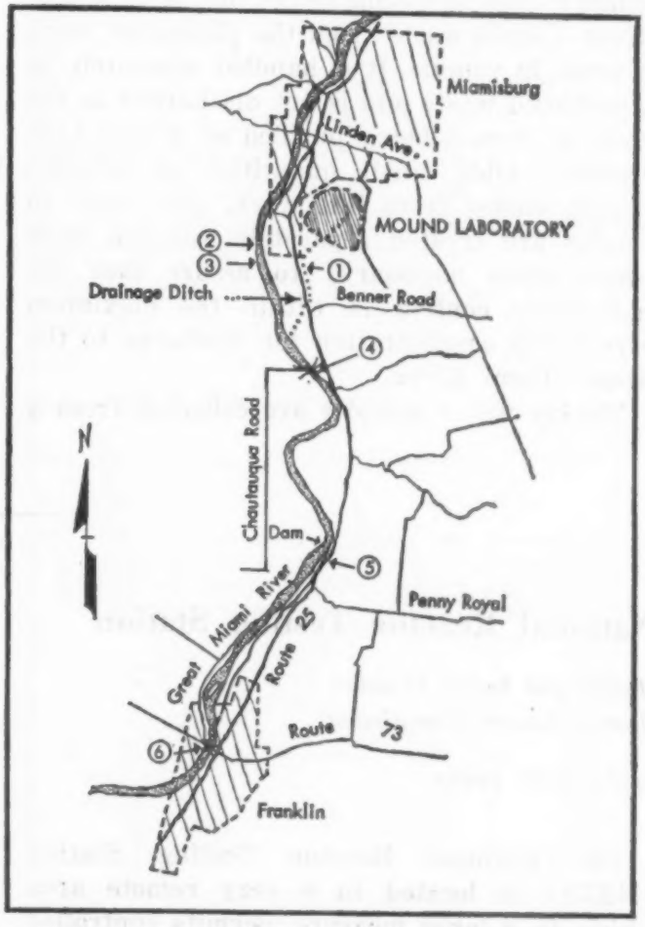

FIGURE 5.—WATER SAMPLING LOCATIONS IN GREAT MIAMI RIVER, MOUND LABORATORY

TABLE 6.—OFF-SITE WATER MONITORING FOR POLONIUM AND TRITIUM, ML

[Average concentrations in μμc/liter]

Station code no. (see figure 5)	Third quarter 1961				Fourth quarter 1961			
	Tritium		Polonium		Tritium		Polonium	
	No. of samples	Concentration	No. of samples	Concentration	No. of samples	Concentration	No. of samples	Concentration
1	9	3,700,000	0	—	11	630,000	0	—
2	9	2,600,000	10	9.4	11	180,000	11	9.36
3	0	—	10	0.36	0	—	11	0.16
4	9	1,400,000	10	2.53	11	270,000	11	0.32
5	0	—	10	0.54	0	—	11	0.64
6	0	—	10	0.72	0	—	11	ND[b]
Others[a]	0	—	0	—	0	—	5	ND

[a] Single samples were collected at five downstream locations between Franklin and Elizabethtown, Ohio.
[b] ND—No detectable activity.

the natural long-lived alpha concentration in air in southwestern Ohio is in the range of and frequently exceeds the MPC for plutonium.

Water Monitoring

Liquid radioactive waste materials from polonium work at the Laboratory are processed in a special waste disposal plant designed to reduce radioactivity to a concentration level at which it may be discharged to the Great Miami River. Liquid waste from the plutonium work is small in volume. It is handled separately as a packaged waste and is not discharged to the river. Helium–3 being purified at Mound Laboratory yields small quantities of tritium. Liquid wastes from this work, also small in volume are treated separately (diluted with water when necessary) to assure that the radioactive content is within the maximum permissible concentration for discharge to the Great Miami River.

Weekly water samples are collected from a drainage ditch and five locations along the Great Miami River as shown in figure 5. The drainage ditch carries away all storm sewer water and liquid tritium wastes from the plant site. Sampling location number 2 is located at the point of discharge of the laboratory effluent to the Great Miami River. Number 6 is five miles downstream from the effluent discharge. Additional single downstream samples were collected at five locations (beyond the limits of the map in figure 5) during the first quarter.

All of the river samples are analyzed for polonium concentration. The drainage ditch samples and some of the river samples are analysed for tritium. Average concentrations of polonium and tritium are given in table 6.

Previous coverage in *Radiological Health Data*

Period	*Issue*
1959 and first quarter 1960	November 1960
Second and third quarters 1960	March 1961
Fourth quarter 1960	August 1961
First and second quarters 1961	January 1962

National Reactor Testing Station

Health and Safety Division
Atomic Energy Commission

Idaho Falls, Idaho

The National Reactor Testing Station (NRTS) is located in a very remote area which, in a large measure, permits controlled releases of radioactivity from the projects with a minimum risk to the environs. The Atomic Energy Commission is responsible for holding environmental radioactivity levels below the Radiation Protection Guides (RPG) recom-

TABLE 7.—ENVIRONMENTAL MONITORING PROGRAM DATA, NRTS, 1961

Type of sample and units	Third quarter 1961		Fourth quarter 1961		Calendar year		RCG's and RPG's (See table 1)
	Number of samples	Average activity	Number of samples	Average activity	Number of samples	Average activity	
Off-site underground water (μμc/liter)	58	α: < 4	33	α: < 4	177	α: < 4	10
		β: < 190		β: < 200		β: < 200	3,000
	56	H^3 <6000	32	H^3 <4000	88	H^3 <6000	1,000,000
On-site production well water (μμc/liter)	203	α: < 4	198	α: < 4	789	α: < 3.5	100
		β: < 190		β: < 200		β: < 200	30,000
	93	H^3 <6000	180	H^3 <5000	273	H^3 <5000	30,000,000
Off-site air filters (μμc/m³)	178	β: 2	163	β: 23	653	β: 7.1	100
Perimeter jack rabbit bones[a] (μμc Sr^{90}/g Ca)	8	10	11	9	45	11	None
Off-site jack rabbit bones (μμc Sr^{90}/g Ca)	13	8	24	12	85	10	None
Off-site milk[b] (μμc I^{131}/liter)	36	< 90	33	< 70	117	< 100	2,000 [b]100
Area monitoring badges (mrem)	23	(Total for quarter) γ < 20 β < 20	25	(Total for quarter) γ < 20 β < 20	118	(Total for year) γ < 130 β < 100	500/year 3,000/year

[a] The reporting of strontium-90 in jack rabbit bones lags the collection of the samples by one quarter year.
[b] During the third quarter 1961, the RCG for milk was changed from 2,000 to 100 μμc/liter and the analytical detection limit lowered from 200 to 50 μμc/liter

mended by the Federal Radiation Council (FRC). The monitoring program is one of the safeguards employed. Descriptions and discussion of the monitoring network procedures have been presented in earlier issues. Table 7 presents the environmental monitoring data for the third and fourth quarters of 1961 and the calendar year averages (see figure 6 for sampling locations).

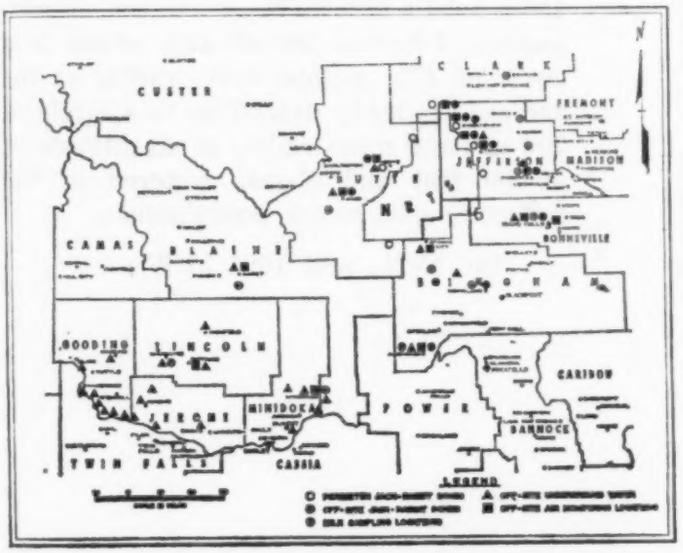

FIGURE 6.—ENVIRONMENTAL MONITORING STATIONS, NATIONAL REACTOR TESTING STATION

In conformance with the Federal Radiation Council's recommendation to the President that the guide value for the iodine–131 intake be established at 100 μμc/day averaged over a period of one year (FRC Report No. 2), and assuming that the consumption of milk will approximate one liter per child per day, the radiation protection guide (RCG) used by NRTS for milk was changed during the third quarter 1961 from 2000 to 100 μμc/liter. This necessitated a refining of the analytical procedures whereby the lower limit of detection was changed from 200 to 50 μμc/liter of milk.

Previous coverage in *Radiological Health Data*

Period	*Issue*
1959 and first quarter 1960	November 1960
Second quarter 1960	February 1961
Third and fourth quarters 1960	May 1961
First and second quarters 1961	January 1962

Reported Nuclear Detonations

May 1962

Since the resumption of nuclear weapons testing in September 1961, summary data have been presented on testing activities during the month preceding publication. Starting with the October 1961 issue, all known Soviet test detonations were numbered consecutively, and in the December issue, consecutive numbering of United States detonations was started. Occasional French tests which have been made since 1960 were not previously numbered, but for convenience in referring to them, numbers have been applied, and the May 1, 1962 French test is reported as the fifth in this series. May 1962 information on all known Nuclear test detonations is summarized in the table below.

Two of the Pacific tests conducted in the vicinity of Christmas Island as part of Operation DOMINIC during the past month were reported as noteworthy: the May 6 launching from a Polaris submarine of a missile carrying a nuclear warhead, and the May 11 underwater nuclear detonation conducted in the Eastern Pacific Ocean, several hundred miles from the closest land areas.

"DOMINIC test series" has been defined as that series of nuclear tests to be conducted in 1962 by the Atomic Energy Commission and the Department of Defense in the areas surrounding Christmas Island and Johnston Island, within the following danger areas:

(1) Effective April 15, 1962 until a date to be announced, an area bounded by a line joining these coordinates:

06° 50′N., 149° 20′W
03° 10′S., 149° 20′W
03° 10′S., 162° 40′W
06° 50′N., 162° 40′W

(2) Effective April 30, 1962 until a date to be announced, an area bounded by a line joining these coordinates:

06° 50′N., 147° 20′W
02° 50′N., 147° 20′W
02° 50′N., 149° 20′W
06° 50′N., 149° 20′W

(3) That area established, effective April 30, 1962, until a date to be announced, encompassing Johnston Island and which is a circle of 470 nautical miles radius at the surface gradually extending to a circle of 700 nautical miles radius at an altitude of 30,000 feet and above, centered at the following geographic coordinates:

16° 45′N., and 169° 31′W

NUCLEAR TEST DETONATIONS REPORTED DURING MAY 1962

Country	Test number	Location	Date	Yield range*	Type of test
France	5	Sahara	May 1	Not announced	Underground
United States	36	Christmas Island	May 2	Low megaton	Atmospheric
	37	Christmas Island	May 4	Intermediate	Atmospheric
	38	Christmas Island	May 6	Not announced	Nuclear warhead in missile launched from Polaris submarine
	39	Nevada Test Site	May 7	Low	Underground
	40	Christmas Island	May 8	Intermediate	Atmospheric
	41	Christmas Island	May 9	Intermediate	Atmospheric
	42	Christmas Island	May 11	Intermediate	Atmospheric
	43	Christmas Island	May 11	Low	Underwater
	44	Nevada Test Site	May 12	Intermediate	Underground
	45	Christmas Island	May 12	Intermediate	Atmospheric
	46	Christmas Island	May 14	Intermediate	Atmospheric
	47	Christmas Island	May 19	Intermediate	Atmospheric
	48	Nevada Test Site	May 19	Low	Underground
	49	Nevada Test Site	May 25	Low	Underground
	50	Christmas Island	May 25	Low	Atmospheric
	51	Christmas Island	May 27	Intermediate	Atmospheric

* Low yield range has been announced as meaning about a nominal (20 kiloton) yield, and intermediate yield meaning the range between nominal and one megaton.

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